

U. S. Circuit Court. Southern District of
New York

American Graphophone Company) In Equity
versus) No. 7063
National Gramophone Company)
and Frank Seaman)

DEFENDANTS' PROOFS FOR FINAL HEARING, 1899-
1900; CONSENT DECREE OF MAY 5, 1900.

Raymond R. Wile
1976.

U. S. Circuit Court. Southern District of New York.

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versus)	No. 7063
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Electrostatic copies of
originals at the Archives
Section -- FRC, Suitland,
Md. (RG 21)

IN THE CIRCUIT COURT OF THE UNITED STATES,
FOR THE SOUTHERN DISTRICT OF NEW YORK.

AMERICAN GRAPHOPHONE COMPANY)

vs.)

NATIONAL GRAMOPHONE COMPANY)

and FRANK SEAMAN.)

In Equity.

#7063

PROOFS FOR FINAL HEARING taken on behalf of Defendants under the provisions of the 67th Rule in Equity, pursuant to agreement, before Gustav Dittmar, Esq., a Notary Public in and for the District of Columbia, acting herein as Special Examiner by consent, at the offices of Lyons & Bissing, Esqs., #908 G. Street, N.W., (McGill Building) Washington, D.C., beginning Tuesday, December 26th 1899, at 11 A.M.

PRESENT:

Philip Mauro, Esq., for Complainant,

Gustav Bissing, Esq., for Defendants.

Defendants counsel offers in evidence the following Exhibits:

-Exhibits-

United States Patents-

1. 27,827, April 10, 1860, Pease, Engraving Machine.
2. 38823, June 9, 1863, ~~Rose~~ Engine Hayden, Rose Engine.
3. 200,521, February 19, 1878, Edison, Phonograph or Speaking Machine.
4. 213,554, March 25, 1879, Edison, Automatic Telegraph.
5. 219,939, Sept. 23, 1879, Hall, Phonograph.
6. 227,679, May 18, 1880, Edison, Phonograph.
7. 283,665, Aug. 21, 1883, Rogers, Automatic Telegraph.
8. 287,166, Oct. 23, 1883, Reynolds, Phonograph.
9. 534,543, Feb. 19, 1895, Berliner, Gramophone.
10. 548,623, Oct. 29, 1895, Sound Record and Method of Making the Same.

English Patents-

11. #1644, A.D. 1878, April 24, Edison, Recording and Reproducing Sounds.
12. #6027, A.D. 1886, (Star) to Johnson as amended Oct. 7, 1890, and the proceedings for the amendment thereof.

French Patents-

13. #124,213, May 15, 1878- Delivered July 27, 1878, to Cros for New Methods in Phonography, translated.
14. Certificate of Addition to Cros patent #124,213, taken August 3, 1878, translated.

Publications-

3

- 15. Comptes Rendus de L 'Académie des Sciences of Dec., 1877, pp. 1082 & 1083, translated.
16. Lehrbuch der Physik und Meteorologie by Muller Pouillet Braunschweig Edition of A.D. 1868, Vol. 2, p. 252, Figures 253 & 254, translated.
17. Poggendorff's Annalen der Physik und Chemie published at Leipzig A.D. 1843, Volume 59, Plate 1, Figs. 1, 2, and 3, p. 145, by Jacobi, translated.
18. The Telegraphic Journal, Vol. 7, p. 53, published at London, February 1, 1879 on the Carbonel Phonograph.
19. Engineering, Vol. 27, p. 326, published April 18, 1879, on Lambrigt's Phonograph.
- 20. Nature, published July 4, 1878, Vol. 18, p. 249, Article on the Phonograph.
21. The Telegraph, Microphone and Phonograph, By Du Moncel, Published by Harper Brothers, A.D. 1879, pp. 247-248.
22. The Telegraph, Microphone and Phonograph, by Du Moncel, Published by Harper Brothers A.D. 1879, p. 238.

Drawings and Photographs-

- 23. Chapman Photographs Graphophone Grooves-
- 24. Chapman Photographs- Gramophone Grooves.

Stipulation.

It is stipulated between the parties subject to correction upon the discovery of error, that the copies of United States patents contained in Exhibits 1 to 10, inclusive, are

true copies; that the copies of British patents in exhibits (11) and (12) and of the proceedings relative to the amendment of the Johnson patent, found in Exhibit 12, are true copies; that the translations of the French patents contained in Exhibits 13 and 14 are correct translations and that they may be used with the same force as if accompanied by the original French Patents; that the cuts and translations contained in Exhibits 15, 16 and 17, are correct cuts and translations of the portions of the publications therein specified, and that they may be used with the same force as if accompanied by printed copies of the original publications; and that Exhibits 18, 19, 20, 21 and 22 are correct copies of the portions of the publications they purport to copy.

Counsel for Complainant, however, objects to Exhibit No. 12 as incompetent, irrelevant and immaterial.

-JOSEPH LYONS-

Being called and sworn as a witness on behalf of the defendants answers to interrogatories propounded to him by Mr. Gustav Bissing, as follows:

Q.1. What is your name, age, ^{residence} and occupation?

A- Joseph Lyons, of legal age, residing in Washington, District of Columbia. I am by occupation a solicitor of patents and mechanical and electrical expert.

Q2. State the general course of your education,

your various occupations up to this time, and whether, and to what extent you are familiar with the science of acoustics and with the arts involving the practical application of that science, and especially with the art of recording and reproducing sounds.

A- I received my technical education as civil engineer at the Polytechnic^C High Schools at Budapest, Hungary, and Vienna, Austria. While studying at these institutions I also became familiar with the use of tools and machinery for metal working and with the manipulation of scientific apparatus of all kinds. My studies comprised, among other things, general physics, and I devoted myself particularly to the study of electricity, optics and acoustics. The laboratories of the Polytechnic School at Vienna, ^{were} ~~was~~ particularly well equipped with acoustical apparatus, and with all of them I became quite familiar and I experimented with them largely, both under directions of the professors and independently of them.

After the completion of my studies, I came to the United States, where I was employed successively on the Board of Public Works of the District of Columbia; in the United States Coast Survey; in the United States Naval Observatory, and then in the United States Patent Office as Assistant Examiner.

During all this time I followed up the developments in general physics and in acoustics in particular. I sought and I received permission from the late Prof. Joseph Henry of

the Smithsonian Institute to experiment with the acoustical apparatus in the possession of that Institution, and I made use of this permission and experimented for a number of years, mainly in the evenings and during holidays, in the laboratory that was placed at my disposition. After ^{the death of} Prof. Henry the same facilities for experimenting were given to me by the late Prof. Baird. The object of my experiments ~~was~~ to verify the fundamental laws of acoustics, systematically, and I was particularly anxious to ascertain the bearing of these laws upon the behavior of vibratory diaphragms. I believe that I attained my object and that in the course of these experiments my familiarity with the use of acoustical apparatus became considerably enhanced.

As Assistant Examiner in the Patent Office, it was my duty to examine all kinds of mechanical structures with the view of determining their mode of operation, their novelty, and their agreement with the descriptions thereof. I thus learned to appreciate essential features of similarity and dissimilarity, in the regular performance of my duties.

I was specially in charge, for a number of years, of all applications for patents for telephones, and, these being essentially acoustical apparatus, I had the opportunity of making use of what I had heretofore learned of acoustics.

During my investigations and examinations of telephones. I also became acquainted with the Edison phonograph, and I read all that appeared in the periodical literature with respect to developments in that line. I witnessed the

performance of the Edison Phonograph on several occasions, and I believe that I was qualified to form a fair appreciation of the same.

I resigned my position in the Patent Office in the summer of 1885, and went to Europe on a tour of inspection and study of the development in the electrical art, and particularly of telephony. Returning to the United States in the spring of 1886, I engaged in the business of Solicitor of Patents and Mechanical and Electrical Expert, and I followed this pursuit ever since.

have
I have prepared and prosecuted a vast number of applications for patents, and among them there was a quite a number of acoustical apparatus, and particularly apparatus for recording and reproducing sounds.

frequently
I was called upon ~~frequently~~ to give, and I did give, expert opinions as respects the validity and scope of patents; as respects sufficiency of description and illustration of inventions, and as respects operativeness, commercial utility and infringement of inventions.

As parties in whose behalf I was engaged in these matters, I may name The Brush Electric Company; The United States Electric Company; the Thomson-Houston Electric Company; the Westinghouse Electric & Manufacturing Company; The General Electric Company, and the Bell Telephone Company.

I have also frequently testified as expert in patent causes, and I have already made an expert affidavit in this suit, in behalf of defendants, in connection with com-

plainants motion for a preliminary injunction.

Q.3- Are you familiar with the various Exhibits which have been introduced in this case?

A- Yes, I am familiar with them.

Q.4- Are you familiar with the depositions of Mr. Cameron given in behalf of complainant in this case?

A- ~~I~~ I am quite familiar with that deposition, since I have acted as cross-examining counsel in connection therewith.

Q.5- Give an exposition of the history of the arts of recording and of reproducing sound up to the date of the filing of the application for patent of Bell & Tainter which resulted in patent #341,2¹⁴~~25~~ in suit; and you may, in this connection, refer to the testimony of Mr. Cameron, in so far as it covers the same ground.

A- The first attempt of obtaining a record of sound vibrations, of which I have knowledge, was that made by the French Scientist Duhamel, either toward the end of the 17th century, or early in the 18th century. The record made by him was really not one of sounds, but of the vibrations of a sounding body, actuated not by sound but mechanically. This was a tuning fork which was set into vibration by a violin bow. This tuning fork was provided at one of its prongs with a ~~kyke~~ style that was brought into light contact with the smoked surface of a sheet of paper, wrapped about a cylinder, which could be rotated and at the same time moved in the line of its axis. When this was done, the vibrations

of the tuning fork would inscribe themselves upon the smoked paper, by the style, in a sinuous line, along which the lamp black deposited upon the paper was scratched away, thus giving a white representation of the vibrations of ^{the} tuning fork upon a black ground. The only object of ~~the~~ Duhamel was to determine the number of vibrations that the tuning fork of a ~~certain~~ ^{certain} pitch would perform per second of time. Incidentally he also obtained the amplitude of vibration of the tuning fork; and when the tuning fork was imperfect, as in most cases it would be, he would also incidentally obtain an image of these imperfections. That is to say, the sinuous line obtained would not be perfectly sinusoidal, but would, by its irregularities, indicate that the tuning fork was capable of vibrating at more than one rate.

The apparatus thus employed was called by Duhamel a Phonautograph, and the same was afterwards improved by several physicists, in succession, down to the present time; and among these improvers are particularly well known the instrument maker Koenig of Paris, and Prof. Helmholtz, the well known scientist.

This remained for a long time the only means for recording vibrations representing sound.

Later on the ~~xxxxxx~~ physicist, Leon Scott, modified the Duhamel apparatus by substituting for the tuning fork a sound receiving funnel, which, at its narrow end, was closed by a vibratory diaphragm, and to which latter a delicate style was attached in a variety of ways. In this manner sounds could be uttered before the wide opening of the funnel and

would be concentrated upon the diaphragm. The latter would then vibrate sympathetically, and the style would now inscribe the movements of the diaphragm upon the Duhamel cylinder. The inscription thus obtained gave the characteristic of each sound that was uttered before the apparatus, showing by its varying forms that the diaphragm vibrated under the simultaneous effects of a variety of sounds, that is to say, of sounds of various ^{itches} ~~features~~ and amplitudes.

To this modified phonautograph it is usual to refer by this name, as if it had originally been applied to it; so that when persons speak of the phonautograph they ordinarily mean the Leon Scott phonautograph. Such an instrument is found in almost every physical laboratory, and there is also one of uncommonly large size at the Smithsonian Institute, where I had occasion to use the same.

It will be seen from this that the phonautograph only gives a pictorial representation of sound waves. Its only use had been formerly to study sound vibrations, both as to the number of vibrations for different pitch, and as to the character of the vibrations depending on the quality of ^{the} sound.

The reproduction of sounds from the graphical records furnished by the phonautograph does not seem to have been contemplated either by Duhamel, or by Leon Scott, or by any of those who improved their instruments.

The first knowledge of the possibility of reproducing sounds from a record of the same seems to have been given
to the world

to the world by Mr. Edison. This was done late in the fall of the year 1877, and it created quite an excitement among physicists, somewhat of the same character as had been created by Daguerre when he announced his discovery of means for fixing the images of the camera obscura. In fact the two inventions have something in common, and the analogy between Daguerre's discovery and Edison's discovery was frequently spoken of when the accomplishment of the phonograph was announced.

While Mr. Edison is the one who first gave knowledge of the possibility of reproducing sounds, from ^a ~~the~~ record thereof, to the world, it seems that the same problem had been considered by a French physicist, Charles Cros, before Mr. Edison; and it is, therefore, proper that Cros' achievements should be related before those of Edison.

It appears that in December 1877, at a meeting of the Academy of Sciences of France, Mr. Cros demanded the reading of a sealed paper which he had deposited with the Secretary of the Academy on April 30th 1877. This paper was read and was found to contain the suggestion of a process of registering and of reproducing sounds.

Charles Cros' sealed paper was published in the proceedings of the French Academy (Comptes Rendus), and a copy of that paper, or, rather, a translation thereof, is in evidence in this case as Defendants Exhibit No. 15. The contents of the whole paper may be summarized as a suggestion that if a phonautographic record is photo-engraved, it may be

used for the reproduction of sound by means of a certain reproducing apparatus. Specifically, the Cros paper says that a phonautographic record may be made upon a disk in substantially the same fashion in which Leon Scott had made a phonautographic record upon the surface of a cylinder. Mr. Cros then says that by the process of photo-engraving the irregular sinuous lines of the phonautographic record may be obtained, either in intaglio or in relief, upon the surface of some resisting material, such as tempered steel. He then says that if the resisting record thus obtained be moved in the same fashion as the surface upon which the original phonautographic record was made; and if, while the record is thus moving, a metal point, or a notched finger, is held by a spring against the sinuous line, such point or finger being connected with a diaphragm; the recorded sounds will be reproduced.

He also suggests that the record might be made upon a cylinder instead of upon a disk. X

It will be observed from this that Cros idea was to make a phonautographic record, fixed in resisting material, and to then use that fixed record for the reproduction of recorded sounds. The fixing of the phonautographic record in resisting material was to be accomplished by the process of photo-engraving. In addition to the phonautograph proper, which was well known at that time, Mr. Cros describes a means for reproducing the recorded sounds in these words:

"A metal point, if the tracing is in grooves (or a notched finger, if it is in relief), is

held by a spring on this tracing, and at the other end the finger which supports this point is solid with the center of the face of ^a suitable membrane for producing the sounds."

The passage above quoted is the only one that describes a novel element of the proposed apparatus and it cannot be said that it conveys a very clear idea of the construction intended by Mr. Cros. Moreover, it does not appear that Mr. Cros ever built such an apparatus. E

Later on, on May 1st 1878, Mr. Cros applied for a French patent which was delivered to him on July 27th 1878, under No. 124,213. A translation of that patent is here in evidence as Defendants Exhibit No. 13. Still later, on August 3d 1878, Cros took out a Certificate of Addition to his patent, and a translation of the same is also here in evidence as "Defendants Exhibit No. 14".

In his patent Cros discloses a great number of ideas with respect to possible methods of recording and reproducing sound. An exhaustive review of all these suggestions is here neither desirable nor necessary, since most of them are obviously quite impracticable, and only prove the ^{fertility} ~~utility~~ of Mr. Cros' imagination. In this patent, however, there is suggested, among the great number of processes, one that deserves notice in connection with this case, and which is set forth in these words:

"The lamp black can be replaced by a body insulating an underlying metallic plate from the engraving action of an acid. In this case the work of the stylus is increased by the cohesion of the insulating substance. Tallow, paraffine, the varnish of aquae fortis can serve.

In this case nothing but an ^{excavation} ~~indentation~~ is obtained which is good for the repetition with a jet of air, or with a solid point entering into the ^{excavation} ~~indentation~~ and causing a sonorous body to vibrate."

The suggestion contained in these two paragraphs are to this effect: Take a metal plate protected against the action of an acid by a superposed layer of tallow, paraffine or varnish of aqua fortis, and trace through that ~~this~~ layer a phonautographic record, and subject the plate to the action of an acid. This will give a sound record in the form of a groove, from which sounds can be reproduced either by means of a jet of air, or by a style entering the groove and causing a sonorous body to vibrate.

What Mr. Cros means by a "varnish of aqua fortis" is not obvious. At least I am not aware of the existence of such varnish, and in fact I cannot conceive of the existence of such varnish. Aqua fortis means nitric acid, and I am not acquainted with a varnish the vehicle of which is nitric acid, and I cannot conceive of such varnish.

It is hardly necessary to say that the suggestion of the use of a jet of air for the reproduction of sound is too wild to deserve consideration. Therefore, disregarding this feature as entirely imaginative, there only remains to be considered the suggestion of obtaining a phonautographic record groove in metal by the action of an acid. Upon this point I shall speak more in detail later on; but I will here say at once that the mere suggestion of ^{tracing and} ~~etching~~ a sound record in metal by the use of a layer of tallow, paraffine, or

any kind of varnish^{and acid,} does not teach anybody how to do it.

Mr. Cameron in his testimony treats the suggestions of Cros quite seriously. He treats them as if they had been realized by Cros and as if he, Cros, had actually made such a sound record. I shall point out further on how much invention and how much experimenting had to be done before any of the suggestions of Cros could be realized.

Before and after the date of the Cros patent some of his ideas were ventilated in periodicals; but since these were mostly incoherent and fantastic restatements of some of the things found in Cros' patent, it is not necessary to refer to them here specifically.

Altogether it does not seem that Cros accomplished anything in practice. There is no record of anything that he actually did. He had ideas, conceptions, hopes, expectations; and he recorded them; but it seems that he neither recorded nor reproduced sounds. The ~~world~~^{world} learned from Cros nothing practical; he gave us neither a drawing nor a machine. While this is so, it must be admitted that the Cros publication indicated a general path that inventors might pursue in order to accomplish the recording and reproducing of, sounds. But the whole tenor of his writings is characteristic of the dreamer. He speaks with the voice of the ~~seer~~^{seer} or the prophet. Some of his visions he records in this fashion:

"I see three kinds of tracings; a transversely undulating tracing; a tracing undulated in depth; a simple linear tracing"etc., etc.

The italics are mine; and I will only observe that neither of the things which Mr. Cros in this fashion saw in his mind's eye did he actually realize.

A distinguished scientist, the Count Du Moncel, in his book entitled "The Telephone, Microphone and Phonograph," an extract from which is here in evidence as "Defendants Exhibit, No. 22," speaks of Mr. Cros' achievements as follows:

"Mr. Edison's phonograph was only patented in January 1877. Consequently, when we look at the principle of the invention, Mr. Cros undoubtedly may claim priority; but it is a question whether the system described in his sealed paper, and published in the *Semaine du Clergé* Oct. 1877, would have been capable of reproducing speech. Our doubt seems justified by the unsuccessful attempts of the Abbé Leblanc to carry out Mr. M. Cros' idea. When we have to do with such undulations and complex vibrations as those involved in the reproduction of articulate words, it is necessary that the stereotyping should in some sense be effected by the words themselves, and their artificial reproduction will necessarily fail to make the slight differences which distinguish the delicate combinations of speech. Besides the movements performed by a point confined to a groove that follows a sinusoidal curve cannot be effected with all the freedom necessary for the development of sounds and the friction exerted on the two edges of the groove will often be of a nature to stifle them."

It will be noticed from this that such ~~x~~ a renowned scientist as the Count Du Moncel not only questions the practicability of what is described in the Cros sealed paper, but he also asserts that a certain ~~xxxx~~ Abbé Leblanc attempted to practice what Cros taught, and failed. In addition to this it is worthy of notice that the Count du Moncel also doubted, ^{generally,} whether it is at all practicable to reproduce sounds from a record consisting of a sinusoidal groove. ~~xx xxxx~~

~~generally.~~

It will here be proper to make clear what kind of sound record Cros proposed to make; in order that I may refer to such sound record, as I proceed, without again describing it.

We have seen that Cros proposed to first make a phonautographic record either upon a smoked surface or upon a surface covered with paraffine or other like substance, and that from such inscription of the sound he proposed to obtain either a groove or a ridge showing exactly the same sinuosities. If in this manner he obtained a groove, such groove would naturally have an even depth all throughout, or practically an even depth. The sinuosities of the sound inscription ^{would then} represent a picture of a line extending to the right and to the left of a median line. Consequently, the groove, if obtained, would likewise extend now to the right and now to the left of ^a ~~the~~ median line. Such sound record has been spoken of, and properly so, in this case, as a laterally undulating sound record.

This then is the kind of record that Cros aimed at, but, as we have seen, never actually obtained.

An August 13th 1878 Mr. Cros took out a Certificate of Addition ^{to} which I have already referred ~~to~~; but it is needless to dwell upon the same, since it contains nothing but an additional suggestion of a mode of recording sounds, and which has in it so many elements of prospective failure, that it does not deserve to be here described. Nobody, as yet, has taken either the Cros patent or his Certificate of Addition quite seriously. In this certificate of addition, again,

there is no drawing. But the patentee says:

"The applications of this system, the property of which I assure^{to} myself by this certificate of addition, are innumerable. In another addition of my patent I will describe the apparatus constructed in detail."

So far as I am aware Mr. Cros never filed another certificate of addition; so that the ~~xxx~~ world remained in ignorance of the kind of apparatus that ^{he} ~~Mr. Cros~~ might have had in mind.

I here desire to call attention to what seems to be an evident error in Count du Moncel's book from which I have above quoted. He there says:

"Mr. Edison's phonograph was only patented in January 1877."....

The date thus ^ascribed to the first Edison patent seems to be wrong, as would appear from the context. The fact is that the first Edison patent describing the phonograph, was taken out in England on July 30th 1877.

Upon the advent of Edison, the laterally undulating record suggested by Cros was entirely lost sight of by the world, except, as we shall presently see, that it was again suggested, for one passing moment, by Mr. Edison himself. In reality, it ~~disappeared~~ ^{appeared} entirely for the time being, and only made its appearance again ten years later, as I shall point out by and by.

The first knowledge of a practicable ~~xxxxxx~~ method of and means for recording and reproducing sound was given to the world by Mr. Edison, and his name has ever since been

associated with this art. He took out quite a number of patents in foreign countries, the earliest of which seems to have been his English patent #2909, dated July 30th 1877. He subsequently took out another English patent #1644, dated April 24th 1878, and he also took out his fundamental United States patent #200,521. ~~Copies of these patents are here in evidence~~ A copy of the United States patent is here in evidence as "Defendants Exhibit No.3," and a copy of his English patent #1644, is here in evidence as "Defendants Exhibit No.11. In practice Mr. Edison adopted particularly the scheme delineated in the principal drawing ^{of} ~~of~~ his United States patent, and the scheme delineated with reference to Figs.1 and 2 of his English patent #1644.

Mr Edison had been at work on improvements in telephones, and he had learned a good deal of ^{the} performances of diaphragms when vibrated by the impact of sound waves. He learned in his experiments that a vibrating diaphragm yielded in reality more work, or was capable of performing more work, than was generally believed. In fact Mr. Edison entertained that a somewhat exaggerated ideas as to the amount of work ~~of the~~ ^{that a} vibrating diaphragm might perform. Entertaining such high estimate of the work that may be derived from a vibrating diaphragm, he conceived of the possibility of impressing the vibrations of ^{such} ~~a vibrating~~ diaphragm directly upon some soft flexible material, and in this manner he was encouraged to attempt the scheme of recording and reproducing sounds. He conceived that if it were possible to impress the vibrations of a diaphragm upon such material in a permanent

fashion, he might cause such impressions to react upon another diaphragm and cause the ~~same~~^{letter} to vibrate in a manner similar to the first diaphragm, and thus obtain a reproduction of sound.

Mr. Cameron, in his testimony, seems to believe that this was suggested to Mr. Edison's mind by the performance of the Bell Telephone, which, so he says, clearly demonstrated that if a diaphragm was caused to vibrate by or in accordance with sound waves, and a second diaphragm were mechanically caused to copy or imitate the vibrations of the first diaphragm, the sound which set the first diaphragm vibrating would be reproduced ~~set~~^{by} the second.

I doubt whether Mr. Edison learned anything, or had to learn anything in this respect from the Bell Telephone. The string telephone, or so called lovers telephone, was known long before the Bell telephone; and whatever the telephone might teach with respect to recording and reproducing sound, Mr. Edison might well have learned from the lovers' telephone.

However this may be, the principal scheme which Mr. Edison pursued and which he realized was as follows:

To a diaphragm provided with a mouth-piece is secured a metallic pin or style; and in front of that style he arranged a cylinder which could be rotated and at the same time moved in the line of its axis. ~~The diaphragm with its style~~ The cylinder which he made of metal had a helical groove cut into its surface, and the shaft of the cylinder had a screw thread equal in pitch to the pitch of the helical ~~groove~~

groove. The shaft was supported in a nut bearing, so that when the cylinder was rotated it also progressed rectilinearly. Upon this cylinder Mr. Edison wrapped a sheet of metallic ~~xxx~~ foil, ordinarily tin foil, and the diaphragm with its style was adjusted toward the cylinder until the style ~~x~~ impinged upon the tin foil, just above some portion of the helical groove, and it impinged upon it with sufficient force to slightly ^{de}press the tin foil, so that it slightly entered the groove on the cylinder. If then this cylinder was rotated, the pin or style would trace upon the tin foil a helical groove, by depressing the foil into the groove on the cylinder. This groove would be smooth and of even depth, so long as the diaphragm was quiescent. But when the diaphragm was caused to vibrate in response to sounds uttered against it through the mouth-piece, the style would alternately press ~~xx~~ more and less against the tin foil, and would, in this manner, produce, in the bottom of the groove, a series of elevations and depressions, corresponding to the ^{to} ~~frs~~ and fro movements of the diaphragm. Such a record has been spoken of in this case, and properly so, as a vertically undulating record, by way of distinction from the laterally undulating record that had been suggested by Cros.

Adjourned until Wednesday, December 27th 1899 at 11 A.M.)

Washington, D.C., December 27, 1899.

Met pursuant to adjournment.

Present- Parties as before.

The witness continues his answer to Q.5, as follows:

From what I have said about the proposed laterally undulating record, suggested by Gros, and the vertically undulating record of Edison, it will be seen at once that by the very words which must be employed ~~in order~~ to characterize these records so as to distinguish them from each other, the characteristic of sound waves are found, in the Gros record, in the configuration of the walls of the groove; while the characteristic of sound waves, in the Edison record, are found in the bottom of the groove. It further follows, that in reproducing from a Gros record the style will be acted upon by the side walls of the groove, receiving impulses from the same alternately to the right and to the left; while in reproducing from the Edison record, the style will be acted upon by the bottom of the groove, receiving impulses upwardly, and allowed, by the resiliency of the diaphragm, to again move downwardly. In other words, the reproducing style ~~and diaphragm connected with it~~ will be vibrated by the Gros record in directions parallel with the face of the material in which ~~the~~ sound groove is formed; while by the Edison record the reproducing style will be vibrated in directions at right angles to the face of the material in which the sound groove is formed.

As I understand it there is no dispute about this point in this case, and in fact there can be no dispute about it..

Since in the formation of the Edison record the tin foil is being depressed into the helical groove formed on the cylinder, (or into a spiral groove formed on a disk, as we shall presently see) it follows, of necessity that those portions of the tin foil which enter the groove will slope downwardly from each side toward and to the bottom of the impression or indentation made by the style. The Edison record groove, therefore, has sloping walls; and these records are generally spoken of as indented records with sloping walls..

Having now generally characterized the Edison method of recording and reproducing sounds, it will be necessary that ~~I will~~^I describe more in detail the mechanisms employed and the procedures adopted by Mr. Edison. These will appear most clearly from the fundamental United States patent of Edison, and from his English patent #1644 of 1878.

In the Edison fundamental United States patent #200,521, there are four figures of drawing, of which Figs. 1 and 2, represent the real Edison phonograph, while Figs. 3 and 4, are illustrations of two fanciful modes of recording sounds, which have never been treated seriously by anybody, and to which I shall hereinafter refer very briefly. In Figs. 1 and 2, however, we have the real Edison phonograph, that is to say, the representation of apparatus that were actually used for ~~the~~ recording and reproducing ~~of~~ sounds.

With reference to Figs. 1 and 2, the patent discloses the following:

There is a cylinder, with a shaft fast on the same, and which might just as well be in one piece with the cylinder. The portion of the shaft which extends from one end of the cylinder is screw-threaded, while the portion of the same which extends from the other end of the shaft is smooth. This shaft has, therefore, one ~~screw~~ nut bearing and one smooth bearing. The surface of the cylinder has formed in it a helical groove, extending from one ^{end} of the cylinder to the other, and the pitch of this helix is the same as the pitch of the screw thread formed on the shaft. There is indicated in the drawing a motor, by which the shaft and cylinder are revolved; and it will now be clear that as the shaft and cylinder are thus revolved, they will also receive a rectilinear movement in the line of their coinciding axes. The cylinder therefore will be both rotated and moved rectilinearly. To each revolution of the cylinder corresponds a rectilinear movement equal to the pitch of the screw, or, what is the same thing, to the pitch of the helical groove on the cylinder. About this cylinder ~~there~~ is wrapped the material which is to receive the sound record; this material is ordinarily a sheet of thick metallic foil, mainly tin-foil; or it may be a sheet of paper, or a sheet of paraffine paper with a metal foil superimposed thereon. The tin-foil or other so-called recording material, is closely wrapped around the cylinder, and in the use of this machine it was found that the

best results were obtained when the tin foil was pressed upon the cylinder rather tightly and smoothly, until it slightly entered the grooves on the cylinder, so that the ^{groove} ~~xxxxx~~ became delineated upon the tin foil.

On one side of the cylinder there is arranged a diaphragm, supported in a suitable mouth-piece, and having a metallic style, a short pin, secured to its center. The mouth piece, and with it the diaphragm and style, is now adjusted toward the cylinder until the style is just opposite the groove on the cylinder, the position of which groove has been made visible on the tin-foil in the manner I have above indicated, and the adjustment is made so that the style slightly presses upon the tin-foil just above the groove. If now the cylinder is rotated, whereby it also ~~xxxxxx~~ receives its rectilinear motion, the style will smoothly press the tin-foil into the groove of the cylinder, so that the tin-foil itself will become grooved; and this groove is of even depth with sloping walls, so long as the diaphragm and style are quiescent. If now, however, sound is uttered against the diaphragm through the mouth-piece, while the cylinder is rotating and progressing in a straight line, the diaphragm will vibrate sympathetically, and the style will depress ~~the~~ or indent the tin-foil, during its ^{forward} ~~xxxxx~~ vibration, to a greater extent than it did when the diaphragm was quiescent; while when the diaphragm in its vibration moves rearwardly, the style will depress or indent the tin-foil less than it did before; and thus there will be formed in the tin foil a

groove of varying depth ;and the variations of depth,that is to say, the undulations in the bottom of the groove,will correspond to the vibrations of the diaphragm,both as respects time and amplitude. There is thus produced,as it were, an image of the sound-waves,in the bottom of the indented groove.

In this operation,which is called ~~the~~ recording,the style will always be coincident with the helical groove on the cylinder,so long as the pitch of the screw-thread on the shaft is equal to the pitch of the groove on the cylinder, and so long as the screw faithfully carries the cylinder along the line of its axis for every part of its revolution. This means that there must be no lost motion; that is to say, there must be no looseness between the screw and its nut bearing,and there must be no difference in pitch between the feed screw and the helix on the cylinder.

For the reproduction of sounds,thus recorded,this patent shows a diaphragm and style mounted ~~on the~~ adjacent ~~to~~ the other side of the cylinder. The style in this case is fixed to a flexible spring^{D,} supported upon a little bracket, and this spring is connected with ^{the} ~~a~~ diaphragm by ~~xxxxxxx~~ ~~or other substance~~ capable of ~~conveying the movements of D~~.

"a thread or other substance capable of conveying the movements of D".

This diaphragm and style is adjusted toward the cylinder until the style enters ~~in~~ the record groove in the tin foil,bearing upon the bottom thereof; and if now the cylinder is again rotated as in the act of recording,the elevations and

depressions in the bottom of the record groove, acting upon the style, will vibrate the spring to which the style is attached, and these vibrations will be communicated to the diaphragm by the "thread or other substance capable of conveying the movements of D", and the diaphragm will then emit sounds, which will be more or less accurate copies of the sounds that had been recorded.

In this connection I desire to call attention to the fact that the "string or other substance capable of conveying the movements of D" are not deemed really necessary by Mr. Edison. This is made evident by the following statement found on page 2, lines 7-10 of the patent, as follows:

"This motion is conveyed to the diaphragm either by vibrations through a thread or directly by connecting the spring to the diaphragm F,".....

It is evident that with a machine constructed in ^{the} manner described in this patent, where the ^{combined} reproducing diaphragm and style is a structure separate from the recording diaphragm and style, it is necessary that the reproducing style be initially adjusted with some accuracy, so that it will engage the record groove and bear upon the bottom of the same. This is made comparatively easy by the fact that the reproducing style is finer than the recording styl^es. It is shown both shorter and finer in the drawing, and the specification points this feature out on page 1, ~~lines~~ 2nd column, lines 2, 3 and 4, from the bottom, as follows:

"In front of this diaphragm is a light spring, D, having a small point shorter and finer than the indenting point on the diaphragm B."

It will be seen further on that this practice of making the reproducing style finer than the recording style has been ~~followed~~ ^{followed} by others, and particularly by Messrs. Bell & Tainter. In fact there is no escape from this practice, so long as the recording style is not at the same time the reproducing style; for, in order that good reproduction be secured, the point of the reproducing style must surely bear upon the bottom of the record groove where the elevations and depressions, that is to say, the record proper is found. Now, if the reproducing style were not small ^{er} _A than the recording style, some difficulty might be experienced in adjusting it so as to bear upon the bottom of the record groove. Once, however, this adjustment is secured, with the machine shown in the Edison patent, there can be no further difficulty; for now the style will always bear upon the bottom of the record groove, throughout the whole length of the record; always supposing that there is no lost motion in the feed screw, and that the pitch of the feed screw is exactly the same as the pitch of the groove in the cylinder.

Since this safe and continuous engagement of the reproducing style with the bottom of the record groove, which has been spoken of in this case as "tracking the groove," is a matter of some importance in this case, I may with propriety point out more in detail what the conditions

of safely tracking the groove are, and how these conditions are secured in the Edison machine .

It is evident that if the feed screw has a different pitch than the helical groove on the cylinder, one revolution of the cylinder will not feed the same in a straight line exactly the distance between ^{the middle of} one groove and the ^{middle of the} next adjacent groove; and in ~~this~~ ^{that} case the style, if it engaged the bottom of the groove, primarily, would, at the end of one revolution of the cylinder, be more or less out of engagement with the bottom of the groove, but would contact with one or the other of the walls of the groove; it would, so to speak, ride up, or crawl up, a side wall, and would not reproduce at all, or ^{would} reproduce so faintly as to be practically useless. It is therefore clear that the pitch of the feed screw should be exactly the same as the pitch of the groove on the cylinder.

Now, if we look at the Edison machine as ~~now~~ shown in this patent, we find that the screw threaded shaft is fixed ^{to} ~~with~~ the cylinder, and might be in one piece with the same. Consequently, the screw thread may be cut upon the shaft in the same gauge-lathe in which the helical groove is cut upon the cylinder. In fact it may be done, and would naturally be done, with the same tool, and without removing the cylinder and shaft from the lathe; it would ^{certainly} be done by the same gauge. It must be understood that ^a ~~the~~ screw is cut upon a shaft, ~~by a~~ or a helical groove is cut upon ^a ~~the~~ cylinder, in the ordinary manufacture of such articles, upon a lathe in which the cut-

ting tool is rectilinearly advanced a certain distance for each revolution of the article. This distance is chosen and once and forever fixed by the operator of the lathe, in accordance with the pitch desired. This being the case, it is evident that a number of screw threads, or a number of helical grooves, can be cut in succession with the same adjustment of the gauge, and with the assurance ~~of certainty~~ that they will all have the same pitch, within the limits of accidental or unavoidable error of a gauge lathe. Now these accidental or unavoidable errors are exceedingly small; so small indeed that for the purposes of a sound recorder or reproducer they would never be perceived.

I have some experience in this matter, since I have myself cut many a screw thread, and also some helical and some spiral grooves upon gauge lathes. I have made micrometer screws with heads divided into ^{one} hundred parts, with an index pointing at the divisions of the head; and it was necessary that each one hundredth turn of the screw shall advance the screw rectilinearly exactly one-hundredth part of the pitch of the screw. Such instruments are quite well known, and while they will never be mathematically accurate, they will always be far more accurate than is required for a sound recording or reproducing machine. The limits of unavoidable error in such micrometer screws are so exceedingly small that they ~~are~~ become only noticeable in accurate geodetic or astronomical observations, in which an error in the instrument becomes multiplied a hundred thousand times, or millions of times. It is only in connection with such measurements that

the unavoidable inaccuracies of micrometer screws need be considered. A sound recording or reproducing machine is, by comparison with geodetic or astronomical measuring instruments, a very coarse affair.

It is, therefore my opinion, that for the purposes of the Edison phonograph the pitch of the feed screw can always be made to be exactly the same as the pitch of the helix groove on the cylinder.

It is also evident that if the nut-bearing through which the feed screw of the Edison machine passes, were loose, so that each turn of the screw would not safely propel the same in a straight line to the full extent of the pitch of the screw, the initial agreement between the reproducing style and the bottom of the record groove would be eventually lost; the style would in this case also leave the bottom and ride or crawl up the incline^d side walls. Now, as respects this looseness or "lost motion," I am prepared to say that it is, quite or can easily be made, quite as small as the the accidental errors in the pitch; for if this were not the case, the great accuracy aimed at in micrometer~~s~~ screws with respect to pitch would be quite useless.

From what I have so far said upon this point it follows, that the combined effect of difference of pitch and of lost motion, in the Edison machine, would be so small as to be entirely negligible. Still it cannot be denied that, theoretically speaking, there will be found, in such machine, always some difference of pitch and some lost motion; but the devia-

tion of the point of the reproducing style from the bottom of the record groove, on these accounts, would be exceedingly small. However, even if ~~they were~~ these deviations were ten times greater than they would naturally be, the construction of the Edison reproducer would take care of this. It will be observed that in the Edison machine the reproducer style is at the end of a comparatively long and slender leaf spring, and that this spring is or may be connected with the diaphragm by a thread. The vibrations which this spring has to perform are in a plane that is normal to the surface of the cylinder; but the spring is so thin and long, and its connection with the diaphragm, when the thread is used, may be so loose, that ~~this spring~~ ^{it} will readily yield in a lateral direction to the extent required to compensate for such difference of pitch, and such lost motion, as may occur in such machine. In other words, the reproducing style has sufficient freedom lateral of ~~xxxxx~~ motion to compensate for any irregularity of lateral motion of the record cylinder, and I have no hesitation in saying that with a machine of this character, constructed with ~~the~~ ordinary care, the reproducing style will always be found at the bottom of the record groove, and will always reproduce the recorded sounds.

There is one other imaginable inaccuracy in a machine of this character that should be mentioned, and this is that the cylinder may not be quite concentric with the shaft. This eccentricity, the existence of which is, theoretically, always present, is practically so small that, in my estimation,

it cannot possibly have any effect upon the operation of either recording or reproducing. As I have stated above, the ^{and} shaft ~~in~~ the cylinder are fixed together, and may be in one piece. They would therefore be turned in the same ~~way~~ lathe, between centers, so that with the commonest care observed in turning them, the eccentricity would be a vanishingly small quantity.

But even if the eccentricity were ten times greater than it would naturally be, the Edison apparatus takes care of this in a very efficient manner. It will be understood that if the cylinder were appreciably eccentric, and if the reproducing style were rigidly mounted, and adjusted in a rigid manner to bear at ^{some} ~~any~~ point upon the bottom of the record groove; the rotation of the cylinder would either withdraw the ~~record~~ bottom of the record groove from the style, or would press against the style with undue force, until the elevations and depressions would be ironed out, or the rather delicate record material would be torn. It happens, however, that the reproducing style is not rigidly mounted, in an unyielding fashion, but is mounted upon a delicate, yielding spring, which ~~xxxx breakingx~~ would yield to increase ^{of} ~~the~~ pressure upon the style and would bring the style again forward toward the record if the same, by reason of eccentricity, should slightly be withdrawn from the point of the style.

I have so far spoken of these theoretical inaccuracies of the machine ~~xx~~ ^{if} in a theoretical manner only; and while I believe that persons skilled in these matters will

concede the accuracy of my statements ; I may say that I do not altogether or exclusively rely upon theoretical considerations , but that I have some practical experience in this matter. ~~I have at my disposal a phonograph~~

I have at my disposal a phonograph of the Edison type, but constructed somewhat differently from the machine illustrated in the patent here considered, and the use of that machine teaches me that all that I have here said as respects the absence of practical differences of pitch, lost motion, and eccentricity, is quite correct. The Edison machine which I have at my disposal is constructed as follows:

The grooved cylinder with its screw shaft and bearings is exactly the same as that shown in the patent, except that the bearings are much heavier than is indicated in the patent, and are formed in standards rising from a base plate.

There is no motor for turning the shaft, but there is a hand crank for this purpose. There is only one diaphragm and style, serving for both recording and reproducing . The diaphragm is mounted in a mouth-piece, which is in turn mounted upon a hand lever, ^{that is} hinged to the top of the same standard in which one of the shaft bearings is formed. This hand lever is at one point reduced in thickness, so as to form a spring, which tends to throw the arm and diaphragm and style toward the cylinder; but the movement toward the cylinder is limited by an adjusting screw. For recording the arm is swung over, parallel with the cylinder, in front of the same, and the free end of the arm is brought down against a lug which limits the

swing of the arm, whereby the latter will always be about parallel with the cylinder, when either recording or reproduction is desired. After the arm has thus been swung around against the lug, it is released, and it is then carried by the spring down toward the cylinder, until it is arrested by the head of ~~an~~ ^{the} adjusting screw of which I have already spoken. The diaphragm is made of mica, and there is a flat spring radially across the diaphragm, which carries at its free end the style; but between the spring and the diaphragm there is interposed a small block of pith, so that the vibrations of the diaphragm, in recording, are transmitted to the style through the pith and spring; and in reproducing, the vibrations of the style are transmitted through the spring and pith to the diaphragm. The adjusting screw which limits the movement of the diaphragm carrying arm toward the cylinder, is so adjusted for recording that the style slightly indents the tin foil, and by this adjustment the little block of pith, which acts as a spring, is slightly compressed, so that the style bears with yielding pressure upon the tin foil. If now the cylinder is rotated and sounds are uttered before the mouth-piece, a sound record is obtained in the usual manner.

The hinge of the swinging arm is adjustable lengthwise of the cylinder, ~~by~~ or rather, the arm ~~is~~ is adjustable on the hinge, so as to bring the style exactly in coincidence with the ~~style~~ groove of the cylinder. This adjustment is made once for all.

My experience with this machine was that if when the arm was once adjusted to bring the style in coincidence with the helical groove on the cylinder, no further trouble was experienced, either in recording or in reproducing. The style would then always be and remain in coincidence with the record groove. I could turn the cylinder, after the record had been made, to any position whatever; the style would always engage the record groove, and give reproduction of the recording sounds. I could, before putting the diaphragm in place, turn the cylinder to any position I ~~xxxxx~~ choose; when I then swung the arm around, parallel to the cylinder, and allowed it to be carried down by its spring toward the cylinder, the ^{style} ~~pin~~ would always engage the record groove.

It is quite natural that this be so, since, as I have explained hereinbefore, there could be no perceptible difference of pitch between the feed screw and the helix ^{groove} ~~and~~, and there could be no perceptible irregularity in either; and there could be no perceptible lost motion in a machine of this character. But if there are such ^{perceptible} discrepancies in the machine, then there is evidently enough lateral yielding of the style, or its supporting spring, ~~or xxxxxxxxxxxxxx~~ to carry the style safely down to the bottom of the record groove. My opinion is that in this machine such lateral self adjustment of the style is not at all required, since I am convinced that the discrepancies above referred to are so exceedingly minute as to escape all observation.

I wish it to be understood that the machine I am here speaking of is not by any means a delicate structure . On the contrary, it is an exceedingly coarse structure; it is one of the coarsest pieces of mechanism that can be conceived. But machine work has been brought to such a high state of perfection, that it is not to be surprised that there is neither a perceivable difference in pitch, nor a perceivable irregularity in the helix; nor a perceivable lost motion; nor a perceivable eccentricity.

Adjourned until Thursday, December 28th 1899, at 11 A.M.

Washington, D.C., December 28, 1899.

Met pursuant to adjournment.

Present- Parties as before.

Witness continues his answer to Q.5.

Mr. Cameron in his testimony desires it to be understood that the Edison phonograph was found in practice to be very imperfect; and he ascribes the comparative failure of the Edison machine mainly to the fact that the reproducer had to be adjusted

"by the exercise of great care and skill" into proper relation with the indented record, and that it was then

"clamped rigidly in position".

Mr. Cameron further says that the Edison record groove is an exceedingly fine thread-like line, and that, therefore the adjustment of the reproducing style into engagement with the bottom of the groove was very difficult to secure, and that even when such adjustment was successfully accomplished, it was by no means certain that it would be maintained; and Mr. Cameron intimates that changes of temperature and consequent expansions or contractions of the parts would be sufficient to disturb the adjustment.

I have heard such language before, before I heard it from Mr. Cameron; but I could never appreciate the justice of it, and my experience teaches me that it is not warranted.

If what Mr. Cameron says were true, then it would simply be impossible to reproduce with the Edison machine. Now, I have heard very good reproduction with an Edison machine, shortly after the same became known, here in this city, in a public ^{amidst} hall, seated thirty or forty feet from the machine, and ~~amidst~~ the bustle and noise of a large audience. With the little modified Edison machine of which I have spoken, I recorded and reproduced sounds without difficulty, and I certainly found no difficulty by reason of changes of temperature. One adjustment of the combined recorder and reproducer was all sufficient; ^{it} required neither great skill, nor great care, and was not disturbed for days in succession either by changes of temperature or anything else. Nor was it necessary to manipulate the machine delicately. In fact the machine was manipulated like any other coarse piece of machinery. The adjustment, once made, seemed to be unalterable by anything that could be done with the machine short of throwing it into the scrap heap. It is true that the initial adjustment had to be made properly; but I experienced no difficulty in this.

When Mr. Cameron speaks of the Edison record groove as "exceedingly fine", and as a "thread-like line", he is certainly correct if he means to speak by comparison with something very broad ~~xxxxxx~~ and deep. A sound record groove is of course not a broad and deep channel; but if the Edison record groove is compared with record grooves made by other machines, and other processes, then it can certainly not be spoken of as exceedingly fine; on the contrary it must then be

spoken of as rather coarse.

The Edison record groove is clearly visible to the unaided eye, and the undulations in the bottom thereof can be followed with the eye without difficulty. This cannot be said of record grooves with undulating bottoms made with modern machines, and I shall have occasion to speak of this more in detail by and by. But as regards the comparative coarseness of the Edison record groove, there can be no mistake. A single glance reveals ~~them~~ every undulation in the bottom thereof.

In the Court record of the suit of ^{the} American Graphophone Company against Loring L. Leeds, James H. White and Leroy W. Baldwin, I find, on page 151, in the testimony of Mr. Arthur S. Browne, in his answer to X.Q. 30, the following:

"The only way I know of of making sound-grooves which are exceptionally deep as compared with the present commercial sound groove, is to use Edison's old method of indenting an extremely pliable material, such as tin foil, but even then no great depth is achievable."

Mr. Browne was testifying in behalf of the complainant in that suit, ^{which} ~~who~~ is also the complainant in this case.

It would seem from this that the Edison record groove is certainly not as fine and delicate as Mr. Cameron conceived it to be. If Mr. Cameron has ever seen an Edison record groove, his memory of the same must have become rather indistinct; since otherwise he could not possibly have spoken of it as something that is "exceedingly fine". The main

cause, therefore, to which Mr. Cameron ascribes the great difficulty of adjustment, does not exist; and with the disappearance of this cause the difficulty also disappears. I certainly found this to be so.

In this Edison patent #200,521, there are described, with reference to Figs. 3 and 4, two different modes of recording sounds. With respect to Figure 3, Mr. Edison proposes to make a sound record that is to be represented by a laterally undulating groove of even depth. This is to be done by forming at the end of the recording style a needle-eye or hook, and feeding a thread through the eye, which thread is to be bent alternately to the right and to the left by the vibrations of the style; and while so bent the thread is to be pressed between rollers into a strip of paper, which would thus be indented with a laterally undulating groove of even depth.

I do not hesitate in saying that this suggestion of Mr. Edison is purely fantastic, and has never been treated seriously by any person who has the least conception of mechanical possibilities. The suggestion simply died. Nobody, so far as I am aware, has ever attempted to make such a phonograph. With x

With reference to Fig. 4, Mr. Edison suggests the making of a sound record, by a pen depositing, along a straight line, more or less ink, according to the ^{varying} pressure which the pen receives by the vibrations of a diaphragm. Mr. Edison also suggests, in a somewhat vague manner, how to use such a sound record for reproduction. But this queer method of sound

recording and reproducing has also disappeared.

In this Edison patent a modification of the machine shown in Fig.1 and 2, is suggested in these words:

"It is obvious that many forms of mechanism may be used to give motion to the material to be indented. For instance, a revolving plate may have a volute spiral cut both on its upper and lower surfaces, on the top of which the foil or indenting material is laid and secured in a proper manner. A two-part arm is used with this disk, the portion beneath the disk having a point in the lower groove, and the portion above the disk carrying the speaking and receiving diaphragmic devices, which arm is caused, by the volute spiral groove upon the lower surface, to swing gradually from near the center to the outer circumference of the plate as it is ~~xxx~~ revolved, or vice versa.

An apparatus of this general character adapted to a magnet that indents the paper is shown in my application for a patent, No.128, filed March 26, 1877; hence no claim is made herein to such apparatus, and further description of the same is unnecessary."

The construction which is thus indicated in general terms, is found illustrated and described in Edison's patent for an automatic telegraph #213,554, dated March 25th 1879, the application for which was filed on March 26th 1877; a copy of this patent is here in evidence as "Defendants Exhibit, No.4."

The invention here described is an automatic telegraph, and for the purposes of this case it is only necessary here to refer to that feature of the apparatus to which Mr. Edison refers in his patent #200,521, by the two paragraphs which are quoted above. This part of the apparatus consists of ^a disk or turn table a, rotated, upon a vertical shaft, in a horizontal plane, and of two styles, each upon a universally mounted arm, held in engagement with the turn table or disk.

The turn table has formed a ~~style~~^{spiral} groove on its upper face, and a corresponding spiral groove in its lower face. The two spirals have the same pitch, and are shown in the drawing as being concentric; in fact they are exactly opposite each other. The arm m, which carries the lower style l, which is in engagement with the lower spiral groove 8, is a bell-crank lever, ~~mounted~~ pivoted in a block o, which in turn is vertically pivoted by a pin ~~xxxx~~ o'. In consequence of this construction it will be seen that the arm m may swing up and down upon its pivot, and may swing horizontally upon ~~the pin~~ the pin o'. The upper arm n, is mounted in precisely the same fashion; it is also a bell-crank lever, and the short arms of these two levers react upon each other in such fashion that as the upper arm n tends to fall down toward the upper face of the ~~x~~ turn table, its short arm, by engagement with the short arm of the lower bell-crank lever m, raises the long arm of the ~~same~~^{letter} toward the under face of the turn table, and eventually the style l, carried by this lever m will engage the ~~groove~~^{spiral} groove 8. The ~~style~~ ~~carried~~ by the upper arm n carries, in fact, two styles, one indenting style 6, and one tracing style 12. The indenting style is actuated by an electro-magnet r, by which it is depressed in response to electrical impulses, and is thus made to indent a sheet of paper that is placed ~~on~~^{upon} the upper surface of the turn table. The indentations are made in accordance with some telegraphic code, such as the Morse code; and these indentations bear a great resemblance to the indentations made by the Edison phonographic recorder; that

is to say, they are of necessity comparatively shallow and narrow grooves ~~of~~ ~~a~~ with sloping walls. The tracing style 12, is mounted upon a leaf spring y, fixed with one end to the lever n, and in the use of this tracing style it engages the indented grooves, and rides up unto the not-indented or less indented portions of the paper, and then again rides down into the indented or more indented portions of the paper, and by these up and down movements makes and breaks an electric circuit, by which similar Morse records are made at a distant station.

The use of the machine as a whole is two-fold; namely for recording telegraphic messages, and for automatically reproducing these messages at some distant station. The recording is accomplished as follows:

By a suitable motor mechanism the turn table is rotated at a uniform speed. The upper lever arm n tends to fall down upon the paper ^{which is} stretched upon the upper face of the turn table; and it does fall down by gravity, until it is stopped by a little spring 13, which comes in contact with the paper. By reason of the engagement of the short arm of the lever n with the short arm of the lever m, the long arm of the latter is forced upwardly, and the pin or style l which it carries, engages the lower ^{spiral} ~~helical~~ groove in the turn table. As this table rotates, the style l, always engaging the ^{spiral} ~~helical~~ groove, is propelled radially across the underside of the table, being allowed to have this movement by reason of the pivot o, upon which the block q turns ^{and} to which block both levers m and n are hinged. It will thus be

seen that as the style l is carried radially across the turn table on the underside, so the arm n with its attachments is carried across the turn table radially on the upper ~~side~~ face of the table. In this movement the indenting style 6 is always immediately above some portion of the spiral groove cut into the upper face of the table. If now electric impulses, corresponding to the Morse code, are passed through the electromagnet r, the ~~xxx~~ pin or style 6 is by each of these impulses forced down upon the paper, always exactly above the groove, and indents the paper as long as it remains depressed. In this manner there is obtained upon the paper a telegraphic Morse record along a spiral line, having indentations of varying length with comparatively blank spaces extending from the end of one groove to the beginning of the next adjacent groove. Of course, when such a recording style comes down upon the paper to indent it, the pressure which it exerts upon the paper, gradually, although rapidly, increases from zero to a maximum; and when the pin or style is again withdrawn from the paper, the pressure which it had exerted, gradually, although rapidly, decreases again to zero. The grooves, therefore, which the style makes are shallower at the ends than in the middle, and these shallow ~~and~~ end portions of each indented groove is spoken of by telegraphers as "tailings" or "tails".

From this it follows, that the record groove thus obtained is of varying depth.

When reproduction of the recorded message is desired, the arm n is again allowed to fall down upon the turn table, until the style l2 at the end of the spring y engages the record groove. The table is then turned as before, and ~~this~~ ^{the} style l2, riding down into a groove and up onto the blank space, and then again down into a groove, and so forth, makes and breaks an electric circuit, and thus reproduces the recorded message at a distant station.

It will be seen that in this machine there is a record groove extending in the line of a spiral; that there is a style which tracks this groove, and which is held in engagement with the groove by gravity, slightly counteracted by the resiliency of ^a ~~the~~ spring, and that this style is mounted upon an arm, which in turn is provided with a universal joint, so that it ^{can} ~~can~~ move up and down, and ^{also} laterally. In other words, the reproducer is mounted on a universal joint, and is held against the record by yielding pressure.

In this same patent Mr. Edison says

"The underneath spiral might be dispensed with, and the spiral on top of the plate might be continued out a greater distance from the center, and the additional spiral used for giving an outward movement to the arm."

(Page 2, 2nd column, lines 10-15).

presently
I shall show ~~forth~~ ^{has} ~~am~~ that the modification here indicated, Mr. Edison ^{has} adopted in the construction of the phonograph in his English patent #1644 of April 24th 1878.

Figs. 1 and 2, of this English patent show the con-

struction of the apparatus. There is a turn table d, moved by a suitable motor about a vertical shaft. The turn table has cut into its upper surface a ^{spiral} ~~helical~~ groove 4, which corresponds to the helical groove upon the cylinder of his United States patent; and there is also an extension ^{3,} of that spiral groove, toward the center of the turn table, as suggested in his automatic telegraph patent. Upon this turn table is stretched and clamped a sheet of tin foil, which may have a ^{center,} hole in its ~~in~~ ^{center,} so as to leave the inner spiral 3 uncovered.

There is an arm i, extending ~~radially~~ radially over the turn table, and the same is pivoted upon a horizontal pin 5, and ^{also} upon a vertical pin 6, the two making a universal joint for the arm. This arm carries at its free end a mouth-piece with a diaphragm and style, and since the arm can freely swing horizontally over the face of the turn table, the style can always be made to be exactly over some portion of the spiral groove 4. Connected with the mouth-piece, ^{or} extending from the same at right angles to the arm i, is a short lug or arm ^{2,} which carries a guide pin or style, intended to engage the ^{spiral} ~~style~~ groove 3. When this pin engages the spiral groove 3, the style on the diaphragm engages the spiral groove 4, and since these two spirals are extensions of each other, and therefore, have the same pitch, it follows that as the turn table is rotated and the arm is swung over the table, by the groove 3 acting upon the pin which engages it, the style on the diaphragm will at all times be exactly over some portion of the spiral groove 4. The arm i ~~is~~ is carried down upon the turn table

by its preponderating weight, or leverage, or both, so that the guide pin and the style on the diaphragm rests upon the tin foil by gravity.

A sound record is made with this machine by rotating the table and speaking into the mouth-piece, and thus is obtained a spirally extending sound record groove in the tin-foil, of the same character as that produced by the Edison machine of his patent #200,521. When reproduction is desired the arm i is lifted and swung back, ^{is put} ~~with~~ the style _^ in engagement with the beginning of the groove, and then the table is again rotated as before. In this case a horn, in the nature of a speaking trumpet, is placed over the mouth-piece, so as to intensify the sounds.

I believe, Machines of this character were, ^{the} manufactured and sold, and ^a general form given to these machines is indicated in Exhibit No. 21, which is an extract from Du Moncel's work entitled: "The Telegraph, Microphone and Phonograph." On pages 247, and 248, are illustrations of the machine. In these machines the record plates or sheets are removable and exchangeable; and the machine was particularly designed for that purpose. Mr. Edison is in the habit of calling the recording diaphragm and style, the "phonograph" ~~while the reproducing diaphragm and style he is in the habit of calling~~ and the sheet upon which the record has been made, a "phonogram"; and using these words in this sense he describes the operation of his machine for recording and reproducing, and the manner of removing the "phonogram", in these words:

"As the disk and sheet are revolved the groove 3 causes the indenting point to occupy a position immediately over the line of the spiral 4, and the indentations will be made upon the sheet of foil in a line corresponding to that of the spiral 4, shown in Fig. 2. The indentations made in the foil are a complete record of the sound vibrations that acted upon the diaphragm b, and from this indented sheet, which I term a "phonogram," the sounds are reproduced. The phonograph is carried outwardly by the spiral 3, and in so doing the parts swing upon the vertical stud 6. By depressing the outer end of the lever i the phonograph is raised so that it can be swung aside from the disk d to allow of the ring frame f being thrown back and the indented sheet or "phonogram" removed from the disk.

(Eng. Pat. p. 5, lines 18-28).

In this construction of apparatus the interior portion of the spiral groove, the portion marked with the numeral 3, takes the place of the screw-threaded portion of the shaft of the machine of patent #200,521; it is the feed mechanism of the machine. But in this case the feed mechanism does not feed or propel the part which supports the recording material, but feeds or propels the reproducing style, or reproducing head. The same idea is also embodied in Mr. Edison's United States patent #227,679, dated May 18th 1880. That is to say, here again the style and diaphragm are propelled over the face of the "phonogram". This is shown in Figs. 3 and 4, which show a machine composed of a vertically mounted cylinder with a helical groove cut into its surface; and this cylinder has a flange upon which a screw-thread is cut ~~having~~ ^{which has} the same pitch as the helix, and which engages a nut by which the diaphragm and style are propelled across

the cylinder, instead of the cylinder being propelled rectilinearly, as in his former United States patent, and as also in this patent in the arrangement shown in Fig. 1. The construction of the apparatus of Figs. 3 and 4, is therefore a kind of cross between what is shown in the original United States patent, and ^{what is shown} in Figs. 1 and 2 of the English patent. The tin-foil or other recording material is again wrapped around the cylinder, which is rotated in any suitable manner upon its vertical axis. Parallel to the cylinder is a fixed shaft or pintle 28, and slipped over the same is a ^{tube} ~~xxxxx~~ 29, which easily turns upon the pintle; and over this tube is passed a sleeve t, which is splined to the tube, so that it can freely move up and down upon the same, while it will turn with the same upon the stud or pintle 28. From the sleeve t extends a bracket partly over the cylinder, and has at its free end the diaphragm and style, and from the tube 29 extends an arm 30, which is acted upon by a spring in such fashion as to turn the tube, and with it the sleeve, bracket, diaphragm and style, around, until the style makes contact with the tin foil upon the cylinder. The sleeve has formed along one of its sides a screw-thread ^{or nut,} which, when the diaphragm and style have been turned by the spring, so as to make the style press upon the tin foil, engages the screw-thread 8 on the flange of the cylinder. It will now be seen that ~~when~~ the cylinder is rotated the sleeve will be propelled upwardly ~~or downwardly~~, upon the tube 29, by the engagement of the ~~xxx~~ screw-thread 8, on the cylinder flange with the screw thread 25 on the sleeve.

The diaphragm holder, being rigidly connected with the sleeve, will thus be propelled parallel to the face of the cylinder. The construction is understood to be such that when the sleeve and flange are in screw engagement, the style will be just opposite some portion of the helical groove on the cylinder, and will press upon the tin-foil and indent the same. If now sounds are uttered against the diaphragm, while the cylinder is rotated, the style will exactly follow the helical groove, and will indent the tin-foil in accordance with the vibrations of the diaphragm. The style and diaphragm are by this operation propelled upwardly.

When the recorded sounds are to be reproduced, the style and diaphragm are swung back by hand from the cylinder, ~~this~~ which disengages the sleeve from the screw thread on the cylinder flange. In this position the sleeve with its bracket and reproducer head would fall down, if released; and in order to prevent this there is provided a little cam 33, which is so weighted that it will automatically turn to clamp the sleeve against downward movement, while it leaves it free to move upwardly. Therefore, in order to bring the diaphragm and style again to its lower position, to the beginning of the record groove, or to any other part of it, the weighted cam must be turned by hand. When this is done the sleeve simply drops down to its lowest position. The reproducer head is then released, and is swung back toward the cylinder by the spring, with the pin in engagement with the record groove. The cylinder is now again turned as before, and sound is re-

produced, the diaphragm and style being again fed upwardly, the style always in engagement with the record groove.

It will be seen that in this construction the reproducer arm is mounted so as to freely turn upon a vertical axis to and from the record, and at the same time to move laterally over the face of the cylinder. We have here, in effect, a universal joint, except that, in the operation of reproducing, the reproducer head is moved in one direction upon a pivot, and in a direction at right angles thereto in a slide.

(Adjourned until Friday December 29th 1899, at 11 A.M.)

Washington, D.C., December 29th 1899.

Met pursuant to adjournment.

Present- Parties as before.

The witness continues his answer to Q.5-

In all of the Edison machines, to which I have referred, the feed screws or feed spirals have a fixed relation to the helical or spiral record grooves. In the machines ~~of~~ ^{corresponding} to his United States patents the feed screws are rigidly connected, and may be in one piece, with the cylinders upon which the helical groove is formed, along which the record groove is made. This is also true of the little machine which I have used myself, and to which I have referred. In the machines of the character shown in his English patent #1644, the feed spiral is on the same disk on which the spiral groove along which the record is made, is formed. Thus it will be seen that the relation between feed and record is, in all these cases, invariably fixed. Consequently, whatever disagreement of pitch there might exist in these machines between feed and record, the same can always be made as small as modern mechanical skill will permit. At any rate, these differences are invariable; that is to say, they are always the same and do not change from moment to moment, or from hour to hour, or from day to day. That these discrepancies are exceedingly small, I have already pointed out sufficiently.

Of the improvements set forth in the Edison United States patent #227,679, there should be particularly pointed out those illustrated in Figs. 5 and 6, which represent combinations of record cylinders with ~~transmitting~~ recording and reproducing styles. In Figure 5, the recording and reproducing style is formed at the free end of ^a ~~the~~ lever, which, between ^{its} ~~the~~ free end and its pivot is connected with the diaphragm. With this construction, if it is used as a reproducer, the vibrations of the style will be transmitted to the diaphragm with reduced amplitude. In the construction shown in Figure 6, one end of the lever is pivoted and the other is connected with the diaphragm, and intermediate between these two points is the style bearing upon the record. With this construction, if it is used for reproducing, the vibrations of the style will be transmitted to the diaphragm with increased amplitude. Mr. Edison emphasized this part of his invention in his specification, in a paragraph extending from line 90, on page 1, to line 7, on page 2, as follows:

"Another feature of invention relates to a lever between the diaphragm and the phonogram, whereby the ~~relative~~ relative movements of the parts may be varied. This lever e has a fulcrum at 15. If the connection to the diaphragm is between the point D and fulcrum 15, as in Fig. 5, then the motion of the point will be greater than the diaphragm, and when used in the phonograph will amplify the indentations in the foil. If used in the phonet, the movement of the diaphragm would be lessened. I therefore prefer, in that instrument, to change the places of the point and diaphragm connection, as shown in Fig. 6, so as to amplify the movement of the diaphragm and increase the sound."

At the period when Mr. Edison took out his patent there was great activity among inventors in telephony, and it

was thought at that time that it would be of advantage to have the vibrations of a transmitting telephone communicated to the microphone portion thereof in an amplified manner; ~~xx~~ ~~ks~~ ~~have~~ so that it was at that time a very common thing to use a system of levers, both for amplifying and reducing the vibrations of the diaphragm. / It was at that time, so to speak, "in the air," to use amplifying and reducing levers.

Immediately after the appearance of the Edison phonograph the scientific world took hold of it, and the phonograph and its possibilities were widely discussed in scientific and semi-scientific periodicals; but it is a noteworthy fact that nobody, so far as I know, ever paid the least attention to Mr. Edison's suggestion of making a laterally undulating record of even depth, found in his United States patent #200,521. The vertically undulating record was the only one that was considered and with which people experimented. Such vertically undulating records were made both in the bottom of a groove and upon elevated ridges. As a sample of the production of the vertically undulating sound record upon ridges, I will refer to the so-called "six-penny phonograph" of Lambrigot, described in Engineering, Vol. 27, page 326, April 18th 1879. A copy of this article is in evidence as "Defendants Exhibit No. 19".

Lambrigot made a vertically undulating record on a convex strip of paraffine, as shown in Fig. 2 of his illustration. He then made an electrotpe from the same, as shown in

Figure 3, whereby the record again appeared in a groove; and ^{lead} he then impressed that record onto a ~~lead~~ wire or wires, and arranged these wires upon a board, as illustrated in his Fig. 1. From these lead-wire records he reproduced, by scraping a paper disk over the lead ridges, and transmitted ^{the} vibrations of this disk through a lead or ~~xxx~~ ^{other} wire to a paper funnel. I may have occasion to refer to this again.

Another inventor, the Abbé Carbonel, also made sound records upon elevated ridges, for reproduction, by ~~re~~ making an ordinary sound record of the Edison type in soft albumen. This gave a sound groove like the Edison groove. He then hardened the albumen and used it as a matrix. In this manner he of course obtained the sound record upon elevated ridges. *However,* Carbonel's method of producing such records is neither ^{does} clearly described, nor ^{as} it recommend itself to the initiated as a practicable ~~thing~~ means of obtaining a good sound record. The Carbonel article is here in evidence as "Defendants Exhibit, No. 18", and I shall have occasion to refer to it again for another purpose.

Q.6. Please consider the patent to Bell & Tainter #341,214, in suit. State your understanding of the nature of the inventions disclosed therein, and the relations of the same to the prior art. In this connection you may refer to the deposition of Mr. Cameron, from point to point.

A. The disclosure in this patent #341,214, marks a decided advance in the art of recording sounds. The sound record produced by Messrs. Bell & Tainter differs from the

Edison tin-foil record in that it is formed by elevations and depressions in the bottom of a very shallow groove, gouged out from a body of wax-like material, as distinguished from a record formed by merely indenting tin foil, or paper, or other like materials.

By the Edison indenting method the formation of one groove affects the configuration of the next preceding groove, if the same is rather close to the latter. And the grooves must be closed together, since otherwise only a few phrases could be recorded upon a comparatively large surface of tin-foil. Even with the record grooves as close together as they are upon the tin-foil, only a few sentences of speech, or a short melody, can be recorded upon an Edison phonograph of medium size.

The grooves are therefore placed as close together as possible. But there is a limit to this closeness, since, if the grooves were much closer together than they are, the formation of one groove would practically destroy the next adjacent groove. The reason for this is that the Edison record groove is formed by bending and stretching, that is to say, by indenting the tin foil. Now, as this material bends and stretches in the formation of one groove, it bends and stretches the material of the the next preceding groove. It might be said that the "sphere of influence" of the recording style extends laterally to the next preceding groove.

Now, by the Bell & Tainter method each record groove is cut, by the removal of material, and it is therefore formed

as if the next preceding groove were not present, or did not exist. That is to say, the formation of one groove does not distort the next preceding one. The consequence of this is that the record grooves may be very close together; and in practice they are placed so close together that the edges of one groove coalesce with the edges of the next adjacent grooves.

But by this method of engraving a sound record, the voice is called upon to do heavier work than by the Edison method, and consequently the grooves are very much shallower; and in order to obtain as long a record as possible, the grooves are also made very much narrower than by the indenting process. This part of the invention of Bell & Tainter is set out in the patent with particular care, and is clearly distinguished from the prior art by express reference to the Edison indenting process. The patentees say that they form their sound record "by means of a cutting style," and they say that the essential new feature of their invention is

"the removal of material to form the record by a cutting, gouging, or graving action of the vibrating style".

They also point out that by the new method more sound can be recorded in a given surface than by the Edison method. They say this in these words:

"In this new or improved form of record not only may a larger number of words or sounds be recorded in a given surface than has been practicable with the indented records heretofore in use, but the recorded vibrations

are also sharper and better defined. It is found that an indenting style smooths over the crests of the larger elevations, and also rubs out some of the finer ones."

(Page 1, lines 50-58)

But What the inventors here say is perfectly true; the engraved record is altogether a more faithful record of sounds than the indented record. The material which these inventors employ, for the formation therein of sound records, they describe as ^{a molten} ~~the melted~~ mixture of one part, by weight, of white bees wax, and two-parts of paraffine. This mixture is spread upon a sheet of paper, or rather card board, and thus forms the tablet, as such structures are now called, for the reception of the sound record. If a Bell & Tainter record is compared with an Edison record, the following differences are found to exist between them.

The Edison record is upon tin-foil, while the Bell & Tainter record is upon a mass of bees-wax and paraffine.

The Edison record groove is formed by indenting, and bears all the marks thereof, while the Bell & Tainter record groove is formed by a sharp cutting tool and consequent removal of material.

The Edison record groove is deep and wide; while the Bell & Tainter record groove is shallow and narrow.

In all other respects the two ~~xxxxxx~~ kinds of record are alike. In both the sound waves are represented by elevations and depressions in the bottom of a groove, and in both the groove has sloping walls; with this difference how-

ever, that the slopes in the Edison record grooves are steep, while in the Bell & Tainter record groove these slopes are very gentle and barely perceptible. That the Edison grooves are very much steeper than the Bell & Tainter record grooves I have already pointed out before, and I have shown that Mr. Browne, testifying in behalf of the American Graphophone Company, in the Leeds case, agrees with me in this respect. How narrow and how shallow the Bell & Tainter record grooves are, and how gently their walls slope toward the bottom, is a matter of some interest in this case, and I therefore find it necessary to dwell upon these points ^{so as} ~~and~~ to make them perfectly clear.

I will say at once that unless a clear appreciation of the configuration of the Bell & Tainter engraved record is obtained, the invention which they have made cannot be appreciated. It must also be remembered that we have here to deal with a rather small thing; with a groove which it would be useless to examine with ^{the} ~~the unaided~~ unaided eye, since it is so small. Still, Bell & Tainter speak in their patent of the different parts of such groove. They speak of the "sloping walls" of the same; they speak of "the bottom of the groove", and of "elevations and depressions" at that bottom; and they ascribe different functions to the different parts of that groove, ^{as} ~~and~~ I shall point out more in detail by and by. This being the case, it is clear that a thorough knowledge of the configuration of the record groove is required in order that the functions which the different parts ^{perform} ~~are to have~~ may be understood. But the groove being

so narrow and shallow, it will be necessary to magnify the same, for inspection and study by the unaided eye.

Now, if we ~~seek~~ search the Bell & Tainter patent for information as respects the configuration of their engraved record grooves, we would naturally expect that this information will be furnished by the engraving tool or style which they use in the formation of the record. This engraving tool is illustrated in the patent by Figs. 5 and 6; ~~but and we~~ might expect but the specification says:

"Figs. 5 and 6, views on an enlarged scale of the graver or cutting style;"

So that, if this part of the drawing gave information as respects the configuration of the record groove, it would give no information as respects the size of it, since the patent does not say how much Figs. 5 and 6 are enlarged. However, the specification describes how the engraving style is made, and says something about the size of it.

On page 3, lines 67-76, the cutting style is described as follows:

"The latter is preferably formed of a round wire by turning the end conical and rounding the extremity, and then grinding off one side to the axis of the wire. This leaves sharp cutting-edges on both sides of the tapering point. These edges remove the material in chips or shavings, like a plane or turning-tool. It is not essential to give this form to the style. Any form which will remove the material and not simply displace it will answer."

In another part of the specification, on page 4, lines

19 to 23, additional information is furnished as follows:

"A penetration of one one-hundredth of an inch has been found very effective, the style being formed of No.16 wire shaped at the cutting end as in Figs. 5 and 6."

This, however, conveys not even an approximate idea of the configuration of the record groove that would be made by such style, since nothing is said in the patent how and to what extent the pointed wire is rounded off at its end before it is ground off on one side to form the cutting edges. Furthermore, a drawing of such a small structure, even if exaggerated, and particularly when exaggerated, is a very uncertain thing. We have hereto do with and to depend upon the steadiness of the hand of the draughtsman who made the drawing.

It may therefore be said, quite properly, that neither the drawing nor the specification gives an adequate idea of the ~~configuration~~ configuration of the record groove made by this process. One thing, however, is certain, and that is that the end of the style is rounded off, and that, consequently, the groove will be curved ^{in cross-section} ~~laterally~~.

We are, however, told by Mr. Cameron, in his answer to disclosed X.Q.65, that the record groove ~~has~~ in the patent ~~is~~ has a substantially the same form as the record grooves formed ^{that are} on commercial machines ~~is~~ built and operated in accordance with patent #341,214, in suit. He says:

"In actual practice when sound grooves are cut or engraved in a solid substance

in accordance with the specification of patent #341,214 in suit, the groove varies greatly in width and is in cross section approximately in the form of an arc."

Again in his answer to X.Q.66, Mr. Cameron says:

"The construction of groove to which I referred in the first part of my last answer is in exact accordance with the groove specifically defined in the patent, that is a groove with sloping walls."

Again, in his answer to X.Q.75, Mr. Cameron, speaking of the enlarged view of the cutting style shown in Fig.6. of the patent, says:

"It must be borne in mind, however, that the cutting portion of this style, being only about the one one-thousandths of an inch from the end thereof, is so small that the width of the groove to be cut thereby, in proportion to the depth, is very great and would, even with the somewhat crude outline shown in Fig.6, give a groove which would be approximately arc-shaped in cross-section."

Again in his answer to X.Q.81, Mr. Cameron said:

~~///~~ The cutting style with which I am familiar is practically the same shape as that described in the patent, ~~though~~ though a somewhat different method is followed in making the same from that described in the patent. As I have repeatedly stated heretofore, the sound-groove being in cross-section approximately that of the arc of a circle, I have no hesitation in stating that it is not necessary that the width of the reproducing style must be less than the average width of the sound-groove."

~~And~~ We see then that Mr. Cameron is of the opinion that a record groove made by such a style as described in the

in cross-section,

patent would be shaped, ~~laterally~~, like an arc of a circle; and that this is the form of groove made by the commercial graphophones, built and operated in accordance with the patent. I fully agree with Mr. Cameron in this respect; and in fact it seems to me that there is no escape from the conclusion that the record groove of the patent is arc shaped in cross section. It now only remains to be ascertained how wide such record groove is, in order to have an exact idea of its configuration. This information is supplied by the commercial graphophone records, which can be bought in the market. In these records it is found that ~~there~~ are almost exactly one hundred (100) record grooves to the inch. Consequently, the maximum width of a record groove would be one-one-hundredth ($\frac{1}{100}$) of an inch. If we now ascertain the nature of the cutting style that is employed for making these grooves; we shall be in a position to tell how deep the grooves are. For this purpose I have examined the cutting style of a commercial graphophone that was bought in the open market, and found it to consist of a cylindrical piece of sapphire, or like jewel, cut off at one end, almost at right angles to the axis of the cylinder, and that this cut-off end is used as the cutting edge. This would, of course, make an arc-shaped groove. I ascertained the size of this cylinder by having a microphotograph made of the same, and having, at the same time, that is to say, with the same magnification, made a photograph of a micrometer scale which shows one-hundredths and one thousandths of an inch. Measuring, then, ^{the} a photograph of the style by the photographed scale, I find that the diameter of

the style is almost exactly five one hundredths ($\frac{5}{100}$), or one twentieth ($\frac{1}{20}$) of an inch. Now, since the groove cut with this style has a maximum width of one-one hundredth ($\frac{1}{100}$) of an inch, it follows, as a geometrical certainty, that the depth of the groove is almost exactly one two-thousandths ($\frac{1}{2000}$) of an inch. From this again it follows that the groove is only one-twentieth as deep as it is wide.

I here produce a copy of each of the photographs to which I have ~~referred~~ referred, and I understand that the same will ~~constitute~~ be made an Exhibit in this case and will be marked "Defendants Exhibit, No. 25, Graphophone Cutting Style and Scale Photograph." The figures which I have given convey a very accurate impression, as respects the configuration of the record groove made in accordance with this Bell & Tainter patent ~~as in xxxxxxxx~~ with upon a commercial machine, to the mind of a mathematician; but in order that a like impression be received by the eye, I had a section of a graphophone recording cylinder photographed upon an enlarged scale, about thirty diameters enlargement, or perhaps a little less. Such a photograph is here in evidence as "Defendants Exhibit, No. 23." The picture which this photograph reveals of a number of adjacent record grooves, is that of a very faintly undulating line. It shows the grooves well enough, but they are, even with this enlargement, so shallow, that the eye is unable to fix upon any particular point and estimate its elevation or depression with reference to another point. The grooves are altogether too shallow for this.

In order, therefore, to aid myself and others in receiving a clear and lasting impression of the configuration of Bell & ~~Tainter~~ Tainter record grooves, I had a drawing prepared, which I here produce, and which shows such grooves about two hundred times enlarged. This drawing also shows grooves of another character to which I shall refer by and by, but the grooves made in accordance with the Bell & Tainter patent are marked "Graphophone Grooves." The drawing shows the edges of the grooves coalescing into common ridges; and this would be the case if the grooves had ~~exxk~~ their maximum width and depth.

I understand that this drawing will be made an Exhibit in this case, and will be marked "Defendants Exhibit, ^{Drawing of} No. 26, Graphophone and Gramophone Grooves."

I (Adjourned until Saturday December 30th 1899, at 11 A.M.)

Washington, D.C., December 30th 1899-

Met pursuant to adjournment.

Present- Parties as before.

The witness continues his answer to Question 6.

A- Having ~~now~~ solved the problem of making a record of sound waves that is free of the ~~defects~~ ^{1/2} which are inherent in the process of indenting, Bell & Tainter found themselves confronted by another problem, namely by that of reproducing sounds from such record. The Edison sound groove was so wide and deep that there was no difficulty in adjusting the reproducing style so as to enter the groove and bear upon the bottom thereof. The groove could be seen by the unaided eye, and the ^{seeing} ~~scene~~ of it was aided by the nature of ^{the} ~~his~~ recording material, tin-foil. Tin-foil presents a bright reflecting surface, and the undulations and depressions in the bottom of the groove are particularly well marked and ⁱⁿ ~~express~~ themselves upon the eye by the reflections of light from the varying curvatures of the bottom. Each elevation and depression is clearly visible. The record material adopted by Bell & Tainter was a dull looking substance that did not regularly reflect light from its surface, but diffused the light. Therefore, even if the Bell & Tainter sound records were as ^{large} ~~prominent~~ as the Edison records they could ^{not} be seen by the unaided eye sufficiently well to adjust the reproducing style to the bottom thereof. But being dull and without lustre, and being at the same time so very narrow and shallow,

it became practically impossible to secure the initial adjustment of the style to the bottom of the groove, by the ordinary means for adjustment. I do not mean to say that a skillful manipulator could under no circumstances bring ^{about} a proper adjustment of the style to the record. Of course, this could be done by the use of a magnifying glass and ^{with} care, but it would in each case be quite a job, and it would always be a matter of uncertainty.

A contemplation of the graphophone grooves as delineated in Defendants Exhibit 26, will convey an idea of the difficulty with which these inventors were confronted. The record, that is to say, the elevations and depressions, from which good reproduction can be obtained, are in the bottom of the groove, as I have repeatedly said, and as I shall more fully point out by and by. Now, when speaking of the bottom of a groove as shallow as that made by the graphophone, some latitude must be given to the meaning of this word. The deepest point of the groove is certainly the bottom of the ~~groove~~ ^{same}; and this deepest point, is, of course, exactly in the middle of the groove. As we pass to the right or to the left from this middle point, we come to shallower and shallower portions of the groove, and eventually we reach the edges of the groove where there is no depth. In the same degree as we reach shallower and shallower portions of the groove we shall also find the elevations and depressions which constitute the record less and less pronounced, ~~pronounced.~~

until they become so faint that they could not give perceptible reproduction. When therefore Bell & Tainter speak of the bottom of the groove, and of the elevations and depressions in the bottom, they must ~~and~~ mean the center of the groove, and may possibly include in this term the parts next adjacent to the center.

I have marked in Exhibit 26 the center of one of the graphophone record grooves by a vertical solid line, and I have marked off equal spaces to the right and to the left of this line by two dotted lines; and I believe that it may be fair to assume that when Messrs. Bell & Tainter speak of the bottom of the groove, they mean primarily the point in the center, and, secondarily, the whole space included between the two dotted lines marked on Exhibit 26. Consequently, the reproducing style, in order to give audible reproduction, should make contact either with the middle point of the groove marked by the vertical solid line, or at ~~some~~ ^{some} point to the right or to the left of the middle point in the space included between the two dotted lines. I do not here mean to convey the idea that I have exactly discovered ~~discovered~~ and accurately marked off that portion of the groove to which the appellation "bottom" will fit. I know quite well that a definite demarkation between the bottom of the groove and the sloping walls thereof cannot be established. It is certain, however, that the ^{deepest} ~~deepest~~ portions which are practically horizontal, of the groove, would naturally be referred to by the term "bottom" and that the ~~maxx~~ shallower portions of the groove

which appreciably slope down toward the practically horizontal position, would naturally be spoken of as the walls. X

The problem, therefore, which confronted Messrs. Bell & Tainter was to adjust the reproducing style so as to make contact and remain in contact with the bottom, which I have undertaken to indicate by the two dotted lines. Now, bearing in mind that Exhibit 26 shows these grooves two hundred times enlarged, it will at once be seen that it will not do to demand that the user of the instrument make that adjustment; nor can it be expected that if he really succeeded in making the adjustment that the same will be maintained ^{for} ~~from~~ any length of time, with a machine of the character described in the Bell and Tainter patent.

Messrs. Bell & Tainter therefore devised means whereby the reproducing style might seek and find the bottom of the groove automatically, and might, from moment to moment, neutralize automatically any tendency of the style to leave the middle portion, that is to say, the bottom of the groove. All this appears from the patent here under consideration; but since the specification and drawings are by no means as clear as they might be, a close scrutiny of this patent will be necessary.

The patent describes and illustrates three kinds of machines. The first, in the order of sequence, is illustrated by Figs. 1 to 11; the second is illustrated by Figs. 12 to 17, and the third by Figs. 18 to 20. There is also shown an electromagnetic recording instrument in Fig. 21, but this has no interest in connection with this case.

Washington, D.C., January 8th 1900.

Met pursuant to adjournment.

Present- Parties as before.

The witness continues his answer to Question 6.

A- The machine illustrated by Figs. 1 to 11, shows a circular disk E, mounted upon a horizontal shaft D, so that the disk will rotate in a vertical plane. ^{Upon} this disk is mounted a circular tablet F of the recording material which is composed of a mixture of bees-wax and paraffine. This tablet can be removed and exchanged against others, the same as in the Edison English patent machine to which I have referred. The disk is rotated by engagement with a friction pinion G, which is driven by a fly wheel ^{and} crank. On the shaft of the ^{gear} disk is fixed a bevel ~~pinion~~ 1, which engages another bevel ^{gear} ~~pinion~~ 4, and one portion of the shaft 5 of the latter is screw-threaded and passes through a nut bearing 6. The bearing of the common shaft of the rotary disk and bevel gear 1, as also the smooth bearing for the screw-shaft of the gear 4, are mounted on a slide C, so that when the disk E is rotated, it will, together with its bearing and the two bevel gears 1 and 4, be moved rectilinearly, parallel to a horizontal diameter of the disk. In consequence of this combined rotary and rectilinear movement of the disk, a fixed point bearing upon the surface of the tablet would inscribe or mark

upon the latter a spiral line, the pitch of which ought to be equal, and will be very nearly equal, to the pitch of the screw thread on the shaft of the bevel gear 4 .

In front of the tablet is pivoted a sound conveying tube 19, and upon this tube is a weight Z, which may be adjusted to any desired position on the tube. This tube is so pivoted that it will swing in a vertical plane at right angles to the plane of the tablet.

For recording there is inserted in the tube 19, another tube 18, which carries ^{ie} at its free end the recording diaphragm and style. Sounds uttered against a suitable mouth piece I, are conveyed ^{by} with the tubes 19 and 18, and act upon the diaphragm 105, and cause the cutting style 11, to vibrate. The weight Z is so adjusted upon the tube 19, that the style, resting by gravity against the tablet, will penetrate into the material of the same to a suitable extent, and when the style is vibrated by sound waves, ^{its} ~~the~~ penetration ~~of the style~~ will vary in depth; and by reason of the rotation and rectilinear progression of the tablet, it will cut into the surface of the same a spiral groove with sloping walls, and having elevations and depressions in its bottom.

These elevations and depressions, in the bottom of the groove with sloping walls, constitute the sound record.

We have seen how narrow and shallow these record grooves are, and that the task of adjusting the reproducing style to the bottom of such a groove could not be entrusted to the user of the machine, and that these inventors provided

mechanism for accomplishing and maintaining that adjustment automatically. This is accomplished by the patentees in this fashion:

When it is desired to obtain reproduction, the recording diaphragm and style are removed by drawing the tube 18 out of the tube 19. Then, for the tube 18 there is substituted a tube 33, which ^{carries} ~~carries~~ at its free end, joined thereto by a short piece of rubber tubing 32, the reproducer head K, with its diaphragm and reproducing style. The reproducer is thus placed at the end of an arm formed by tubes 19, 33 and rubber tubing 32, and, if allowed to do so, will fall forward toward the record tablet.

The little piece of rubber tubing acts kind as a kind of universal joint, allowing the reproducer head, as it falls forward in turning about the horizontal pivot of the tube 19, to have a slight lateral movement either to the right or to the left. The effect of this is that when the reproducer is thus allowed to fall forwardly toward the record tablet, the style might, perchance, come to fall exactly into a record groove and into the bottom thereof. If this happens the universal joint does not come into action. But it might also happen, and it is more likely to happen, that the point of the style will strike one of the side walls of a groove, or will strike the common ridge into which the walls of two adjacent grooves coalesce. In the first case the style will slide down the inclined wall of the groove which it struck, and in the second case it will fall from the common ridge down ~~into~~ into one or the other of the two adjacent grooves,

and in both cases the point of the style will settle in the bottom of the groove.

It will be seen that in order to reach the bottom of the groove, either from the edge or from a point on the side wall, the style must be ~~allowed~~ free not only to move forwardly at right angles to the face of the tablet, but also laterally, parallel with the face of the tablet.

This is the function of the universal joint formed by the rubber tube, and seeing that the slopes of the grooves are so exceedingly gentle as I have shown them to be, there should be practically no resistance to the lateral movement of the reproducer head and style. Now, a short piece of rubber tubing, if it is flexible enough, will offer practically no resistance to such lateral movement, since the extent of movement required is, at the maximum, not more than one-half the width of the groove, that is to say, one-two-hundredths ($\frac{1}{200}$) of an inch, in commercial machines. It is absolutely necessary that there be practically no resistance to lateral movement offered by the rubber tubing; for if there be an appreciable resistance the style could not slide down the exceedingly faint slope of the wall of the groove.

The specification of this patent is not as clear as it might be; in fact it is in many places so obscure and indefinite that in order to get at its meaning it is necessary to resort to interpretation, such as is afforded by the context and by common sense. Still the patent gives a tolerably clear idea of the function which is assigned to the the universal joint afforded by the short piece of rubber tubing.

The patent says about the reproducer and its functions as follows:

"The invention consists, fourthly, in loosely mounting the reproducing-style so that it can readily be guided by the record. Preferably the reproducing-style, or rather what may be called the "head" of the reproducing-instrument, is mounted on a universal joint, and the style is pressed against the record by the yielding pressure of a spring or weight. Practically in the instruments made by us the pressure is due to the weight of the instrument, modified by the elasticity of a section of soft-rubber tube, which supports the same and constitutes a universal joint; but evidently there are many devices which can be used to mount the reproducer, so that it is free to follow the sound record or phonogram, and which, therefore, would be within the spirit of the invention. The reproducing-style, mounted as just explained, is specially adapted for use in connection with a record in the form of a groove with sloping walls, and this combination is specially claimed; but it may also be usefully employed in connection with other forms of record."

(Page 1, line 84, to page 2, line 3).

Again on page 4, lines 58 to 84, the specification says:

"The reproducer K when so placed is mounted upon a hollow standard composed of the tubes or tubing 31, 32, 33, and 19, and in consequence of the flexibility of the rubber tubing 32 it is free to follow the record. No special care is necessary to insure its adjustment, for if the reproducer K be allowed to rest against the record with the style upon the engraved line the style will of itself gravitate to the bottom of the groove.

There exists always a liability to disarrangement in some part of the machine either in the recorder or the support therefor or the recording-tablet or its support, or if there be no disarrangement it would be difficult to insure that the reproducing-style should touch the record precisely at the proper point if the reproducer be held rigidly. Difficulties on these accounts are avoided by the loose or flexible mounting of the reproducer, the style automatically adjusting itself to the proper place on the record. It will be seen that the reproducer is mounted on a universal joint, so that it can move in any direction. The movement parallel with the face of the tablet would, however, by itself allow the style to follow and adjust itself to the record to a useful extent."

I have here quoted every word that is found in the specification of this patent with respect to the function of the section of flexible rubber tubing which constitutes the universal joint. The part which is most expressive of this function is comprised in this passage:

"No special care is necessary to insure its adjustment, for if the reproducér K be allowed to rest against the record with the style upon the engraved line the style will of itself gravitate to the bottom of the groove."

This passage describes, very briefly, all the uses of the universal joint, which I have pointed out more in detail. It is the automatic adjustment of the style point to the bottom of the groove which is aimed at, and which is secured by the universal joint.

I find that precisely the same function is ascribed to the universal joint, combined with the yielding pressure, by Mr. Charles S. Tainter, in his deposition in the Leeds case. He there says in answer to Q.7:

"Answer- The difficulty of tracking the groove increases as its width and depth ~~diminish~~ diminish.

With record grooves equal in size and shape, the reproducér will follow a pitch of ~~xxx~~ ten to the inch as readily as it will one of one hundred; but should the reproducér, for any reason, leave the groove, it might, in the case of the coarse pitch travel along on the surface of the record cylinder between the grooves, while with the fine pitch the space between grooves being too narrow to support the reproducér the motion of the cylinder throws it to one side or the other and into the groove. If, in the case of the coarse pitch, the width of the groove is made equal to the pitch, the tracking will be less difficult than in the case of the finer pitch, as there is no place

for the reproducer to rest outside the groove, and when the groove is large it is most effective in guiding the reproducer. ~~but of a fine~~
A disturbance that would throw the reproducer out of a fine groove would not interfere with the tracking of the large one.

(Pages 190-191.)

deposition,

Again, in the same ~~xxxxxx~~ ^A Mr. Tainter is asked and answers as follows:

"X.Q.24. In reference to the ^racking of the reproducer in the sound groove you state in answer to question 7 that

"With the fine pitch the space between the grooves being too narrow to support the reproducer the motion of the cylinder throws it to one side or the other and into the groove."

Do you mean by that statement that in the case of the record grooves being fine and close together the reproducer stylus cannot ride between any two grooves (even if momentarily displaced from one of them), ~~but~~ will slide down the sloping sides into one or other of the two grooves on either side of the dividing ridge?

A- What I mean by this statement is that with what we call a fine pitched record the dividing ridge between any two grooves is nearly if not quite sharp at the top. While it would be possible perhaps to make the reproducer rest upon this ridge while the record surface is stationary, the moment the recording surface is put in motion the reproducer will be thrown off to one side or the other and into the groove.

(Pages 198-199)

All this perfectly agrees with the opinion I have expressed as respects the function ~~of~~ ^{and} utility of the universal mounting of the reproducer. ~~It will~~

It is quite clear that, as the style seeks the bottom of the groove, it is guided in its universal movement by one of the sloping walls of such groove. These walls have

also elevations and depressions impressed upon them by the cutting style; but they are fainter and fainter the nearer they are to the edge of the groove, and are really ineffective for practical reproduction. Still they ^{are the} ~~have~~ ^{of} impressed upon ~~them~~ sound waves, and it may therefore be properly said that the style, as it automatically adjusts itself to the effective part of the record in the bottom of the groove, ~~it~~ is guided in its movements thereto by the practically ineffective portion of the record along the wall.

Now it is evident that if the style is to move in the manner described in the specification, and pointed out by Mr. Tainter, one of the inventors of the graphophone, such style must be narrower than the record groove, since otherwise it could not be moved laterally within the same, from the sloping wall down to the bottom. Upon this point Mr. Cameron has some misgivings; he is not sure that the reproducing style must be narrower than the record groove. In my ~~own~~ opinion there can be no doubt about this, and we ought to find in the Bell & Tainter patent some indication upon this point. The specification, however, says very little about this; it only says that the reproducing style which is shown in Figures 7-10, is

"formed of a narrow metal strip bent near the end, as shown in Fig. 8, and pointed, as shown in Figure 7."

This in itself conveys no definite idea as to the comparative size of the reproducer style point. The drawing certainly shows it smaller than the recording style; but the

reproducing style

recording style is represented upon an enlarged scale, while the reproducing style is not so represented. It is therefore true that the specification does not directly inform us that the reproducer style is narrower than the recording style, and consequently narrower than the record groove, and we can only judge from the fact that the style must be free to move laterally within the groove, that it must be narrower than the latter.

I find that my conclusion is correct, from the fact that Mr. Tainter, in his patent No. 341,288, dated May 4th 1886, which is also here in suit, when describing the reproducing style says:

"The outer end of this style (which should be somewhat more tapering at the point than the recording style) rubs over the record or tablet."
(Page 6, lines 72-75)

This, in my opinion, should remove every doubt on this subject, since it cannot be assumed that Mr. Tainter would make his reproducing style narrower than the recording style for the mere fun of it. In fact it is quite clear that the reproducer style must be narrower than the recording style, and consequently narrower than the record grooves, in order that it may operate to automatically adjust itself to the bottom. This action, Mr. Tainter describes in his patent No. 341,288, here in suit, with particular clearness, on page 8, lines 83-93, as follows:

"It is then released, and the reproducer, falling forward, brings the style into contact with the record. Preferably the grooves are so close together that the ridge between them

tapers to an edge on top, so that no matter where the reproducer may be placed the style will enter a groove, and being free to move sidewise will, owing to the sloping sides of the groove, penetrate to the bottom thereof under the action of gravity.

In order that this action be possible the reproducing style must be narrower than the record groove, and as I have pointed out above, Mr. Tainter, in this same patent, says that it is narrower.

In practice the same thing is found; the graphophone reproducer style is thinner than the recording style. I have hereinbefore shown how I ascertained the thickness of the recording style that is found in public use in connection with the commercial graphophone; and that the thickness of the recording style thus ascertained is almost exactly five one-hundredths ($\frac{5}{100}$) of an inch, or one-twentieth of an inch., and I have produced Defendants Exhibit No. 25, which explains the method I pursued. Now, in the same manner I also ascertained the thickness of the reproducing style. I had a microphotograph made of such style, on the same scale as the microphotograph of the recorder, and I measured the point of the reproducer style by the micrometer scale which was also photographed with the same magnification. I here produce, upon one sheet, a photograph of the reproducing style and of the micrometer scale, and I understand that the same will be made an exhibit in this case, marked "Defendants Exhibit No. 27, Graphophone-Reproducer-Style, and Scale, ~~and Scale~~ Photograph." Now, measuring the style by the scale, I find ~~xx~~ that the

diameter of the style is almost exactly four-one-hundredths, or one-twenty-fifth of an inch.

It will be noticed that the point of the reproducer is spherical in form, and if this small sphere is inserted into the curved record groove made by the cylindrical style of Exhibit No. 23, it will touch that groove at one point only; and the point which it is intended to touch is the middle point of the groove, or somewhere close to the middle point, that is to say, at some point between the two dotted lines marked on Exhibit No. 26.

In connection with the machine illustrated by Figs. 1-11, the patent shows the reproducer style so mounted that it extends diametrically over the face of the reproducer diaphragm, and projects with its point beyond the edge of the reproducer head, and is at that end curved downwardly, so that it may bear with its point upon the bottom of the record groove. It seems that Messrs. Bell and ~~Tinker~~ Tainter believed that this extension of the point of the style beyond the edge of the reproducer head is worthy to be called an invention. They say:

"The invention consists, sixthly, in a reproducer or reproducing-instrument in which the reproducing-style, instead of being placed behind its support, projects at the point beyond the edge thereof. One practical advantage of this is that it enables the position of the style on the record or phonogram readily to be observed."

(Page 2, lines 14-21.)

Of what use it can be to observe the position of the

style on the record, Messrs. Bell and Tainter do not state. I certainly can find no use in this, particularly with a record that is ~~xx~~ formed in such ~~xx~~ exceedingly fine grooves that it is practically impossible to distinguish one from the other with the unaided eye. In the practical graphophone, such as is found in the market, the style of the reproducer does not project beyond the head, and can, therefore, not be seen; and so far as I am aware no inconvenience arises from this. In my estimation, therefore, there is no utility in this feature of the Bell & Tainter construction, and if there were any utility in it (which there is not) it would certainly not mark an invention. Moreover, I find that long before the filing date of the Bell & Tainter patent, reproducer ~~xx~~ styles were mounted at the end of arms which projected far beyond the edge of the reproducer head. I find such case well shown in the patent to A.W. Hall #219,939, dated Sept. 23rd 1879; ^{*Defendants Exhibit No. 5.*} In that patent there is shown, in Figs. 3 and 4, a reproducer head ^{with} ~~at~~ its diaphragm A. To the center of this diaphragm is secured an arm G^2 , which projects far beyond the reproducer head, and has two reproducing styles secured to its free end, which, for this purpose, is forked. Mr Hall uses what he calls a "duplex or divided record", and therefore needs two reproducing styles for effective reproduction; but he ~~xx~~ says in his specification, on page 3, 1st and ~~xx~~ 2nd columns:

"Although the greatest advantages resulting from the use of a lever between the diaphragm and the recording-surface are obtained by the use of

two points giving a duplex or divided record, the advantage of leverage between the diaphragm and the recording-point would be considerable with a single point giving a single or undivided record."

This shows that Mr. Hall would use a ^{single} style mounted so as to be far beyond the edge of the reproducer, if he had a single or undivided record, such as Bell & Tainter ^{have} _A Mr. Hall evidently did not think that by ^{pl} ~~placing~~ the reproducer style beyond the edge of the reproducer head he had made an invention; and I believe that he had made none; and I believe that Messrs. Bell & Tainter had made none, by the same practice.

In addition to the machine illustrated and described by reference to Figs. 1 to 11, Messrs. Bell & Tainter illustrate and describe two other machines. One such machine is illustrated in and described with reference to Figs. 12 ~~and~~ to 17, which I will call the second machine. This second machine has this in common with the first machine, that the record is engraved spirally into the face of ^a ~~the~~ _A circular flat tablet, which is both rotated and moved laterally; it is not moved laterally in a straight line, as in the first machine, but is moved in a curved path. Here again the reproducing style is held comparatively fixed with reference to the lateral movement of the tablet, but is also provided with a universal joint in the shape of a short section of rubber tubing, which would allow the ~~style~~ reproducer head and style a universal movement, if it ever came into action. In this machine, however, the universal movement, and in fact the reproducer, so far as I can understand it, can never come into action, since the

machine is not adapted for reproduction of the recorded sounds by means of the instrumentalities shown. In other words, I look upon this machine as inoperative for reproduction. Mr. Cameron, who is supposed to be very familiar with this patent, does not know how to reproduce sounds with such machine, as is evidenced by his testimony, in which the following appears:

"X.Q.181- You misunderstood my last question. From the drawing and from the description of the patent you have deduced certain possibilities of adjustment of the reproducer with reference to the record tablet for the purpose of reproducing. Now, will you please make use of these possibilities and state how you as an expert would manipulate this machine in the attempt of reproducing sounds recorded upon a tablet?

A- As I have heretofore intimated that ~~it~~ it is impossible to obtain from the patent any positive idea as to the manner in which the reproducer is to be moved in order to bring it into operative relation with the record, it would manifestly be impossible for me to state with accuracy just how I would proceed to manipulate the reproducer in ~~the~~ ~~xxx~~ order to reproduce from a record. For this reason it would be impossible for me to answer your question and state how I would manipulate the machine in an attempt to reproduce sounds recorded upon the tablet.

X.Q.182- You are experienced in reading patent drawings and you are experienced in reading and interpreting patent specifications. It may therefore be said that the machine represented by Figs.12 and 13 of the patent here under consideration, is now before you. You are also an expert with respect to sound recording and reproducing machines, and the question now is whether you would undertake to use the machine in question for reproducing sounds?

A- With a reproducer constructed and mounted precisely as shown in Figs.13, I cannot say that I would."

I find myself in precisely the same position as Mr. Cameron: With a reproducer constructed and mounted as shown

in the Bell & Tainter patent, I cannot say that I would undertake to reproduce recorded sounds with their second machine.

There is a 3rd machine illustrated by and described with reference to Figs. 18-20. I am free to say that this represents a mechanism which, while theoretically quite correct, would be found in practice ^a the most embarrassing structure. I am not aware that anybody ever attempted to build and use such machine, and I really do not believe that anybody would ever seriously attempt it.

In this machine the record groove is to be engraved into the face of a travelling band or strip of suitable material. For reproduction, the reproducer head is rigidly clamped in position, after having been adjusted by hand to make the style engage the record groove, so as to bear upon the elevations and depressions in the bottom thereof. The style, however, has a kind of universal mounting. It is mounted upon a thin rubber diaphragm, which, of course, would allow the style an exceedingly small free movement in all directions. It would possibly allow the style as much free universal movement as is allowed to the Edison reproducer style, in the construction shown in his United States patent #200,521. (Exhibit #3); but certainly not more. This extent of freedom of movement would probably be all sufficient.

I think I have now referred to every feature in the Bell & Tainter patent ⁱⁿsuit which it is necessary to consider, in order to understand the position which these inventors hold in the art, and I may now summarize the features of the Bell & Tainter machine and process which are in common with the prior art

with the prior art, and also the features with respect to which they depart from the prior art.

I find that the Bell & Tainter process and machine have the following features in common with the prior art:

A- A sound record which is represented by elevations and depressions in the bottom of ^athe groove with sloping walls, of the general character of the records made by Edison and his followers.

B- Sounds are reproduced from this record by giving to the tablet both a rotary and a rectilinear movement, while the style is held in a relatively fixed position, the same as in the Edison patent #200,521, and in the various modifications of the same.

C- The reproducing style is narrower than the record groove, and bears with yielding pressure upon the elevations and depressions, i.e., upon the record, in the bottom of the groove.

D- The reproducer style can adjust itself laterally within a record groove, as in Edison's United States patent #200,521, and in ~~Figx~~ Figs. 1 and 2 of his English patent #1644 of 1878.

E- The reproducer head is mounted upon a universal joint, as in the Edison English patent.

The points wherein the Bell & Tainter process and machine depart from the prior art, are

a) The sound record is engraved upon a body of wax instead of being indented in foil or paper; and in consequence thereof

b) The record grooves are very much narrower and very much shallower, and have walls that slope very much more gently than in the prior art; they are also much ^{deeper} ~~shallower~~, and do not affect each other.

c) The feed screw and record spiral are not in a permanently fixed relation, as in Edison, but are in a relation that may vary from moment to moment.

d) Greater freedom of lateral movement, and to a very slightly greater extent, is given to the reproducer style, in order that

e) The style may adjust itself automatically to the bottom of the very shallow record groove, so as to make and maintain contact with the elevations and depressions which represent the sound waves.

I believe it is quite clear from all this that Messrs. Bell & Tainter have set to themselves the task of improving the Edison process ^{and} ~~in~~ machines; that in all their work, so far as it is disclosed in their patent #241,214, they followed the footsteps of Mr. Edison, and only deviated from Edison in one essential particular, namely, in ^{discarding} ~~describing~~ the indenting process and substituting therefor the engraving process. It may be said, in justice to both Mr. Edison and

Messrs. Bell & Tainter, that the latter are the epigones of the former.

(Adjourned until Tuesday January 8th 1900, at 11 A.M.)

Washington, D.C., January 9th 1900.

Met pursuant to adjournment.

Present- Counsel as before.

Q.7- In your last answer, in summarizing the features with respect to which the Bell & Tainter machine of patent No. 341,214 differs from what is shown in the prior art, you say under the head (c), that the feed screw and record spiral are not in ^{such} a permanently fixed relation as in the Edison's machines, but are in ~~the~~ ^a relation that may vary from moment to moment. Will you please explain the meaning of this difference briefly?

A- . I have heretofore pointed out that in all the Edison machines there is a feed screw or a feed spiral by which the record tablet is rotated. In some of these machines the feed screw also gives to the record tablet a rectilinear movement, that is to say, it feeds the same laterally past the recording and reproducing styles. This is notably the case in the construction of the machine shown in the Edison original United States patent #200,521, and in Fig. 1

of the Edison patent #227,679. In other Edison's machines, as for instance in the machine shown in Figs. 3 and 4 of patent No. 227,679, and in the machine of his English patent No. 1644 of 1878, the feed screw and feed spiral respectively, do not feed the tablet, but feed the recording and reproducing styles laterally over the record tablet.

Now, in all these machines the feed screws and record helices, or the feed spiral and record spirals, are rigidly connected, and sometimes are, and in all cases may be ^{on} one and the same structure. Consequently, the relations of the feed and record helices or spirals are permanent; they are fixed and cannot change. Therefore, if there is any disagreement between them, such as ^a difference of pitch, then this disagreement is permanent, and can be made exceedingly small. All this I have already explained.

Now, when we come to the Bell & Tainter machine we have an entirely different state of affairs. The feed screw which is marked in Figures 1 and 2 by the numeral 5, is one structure, and the record spiral ~~xxx~~ ~~xx~~ ~~the~~ is on the tablet which is mounted on the rotary disk E, which is an entirely different structure, but which is geared to the feed screw by bevel gears 1, 4. Consequently, the feed screw and the device that supports the tablet in which the record spiral is formed are two independent structures, and motion from one is transmitted through gearing to the other. In this transmission of motion through intermediate gearing there is always some lost motion, some irregularity, and this lost motion and irregularity

is not the same from moment to moment, but is liable to variation, and in the nature of things will vary from moment to moment. By reason of the variability of the relation between feed and record, introduced for the first time by Messrs Bell and Tainter, the ~~necessity for~~ ^{utility of} automatic adjustment of the reproducing style to the bottom of the record groove is greater in this machine than it would be in the Edison machine; moreover, the freedom of lateral movement of the style must, on account of this variability, be slightly greater than it has to be in the case of the Edison machine.

Q.8. Please consider Letters Patent No. 341,288 to Tainter, here in suit, in so far as the subject-matter of claim 44 is concerned, and Letters Patent 375,579 to Tainter, here in suit, in so far as the subject matter of claim 20 is concerned, and state the relations which these patents bear to the prior state of the art.

A- The Tainter patent #341,288, which was issued on the same day as the Bell and Tainter patent here in suit, describes improvements or modifications of what is shown in the Bell & Tainter patent. Mr. Tainter makes this clear in his specification on page 9, lines 91-98, as follows:

"The present invention is to be considered as an improvement upon or modification of what is shown and described in the application for Letters Patent of C.A. Bell and myself, filed June 27, 1885, and officially numbered 170,044, so far as they relate to common features, and no claim is made herein to any matter described and shown in that application."

The specification of this patent contains restatements of some of the inventions set forth in patent 341,214, and in much clearer language than in that original patent. The machine as a whole is a vast improvement upon the original machine, and so far as I am aware it was this second form of machine that first came into public use. The improvements made by Mr. Tainter upon the joint work of Bell and Tainter are recited in a number of counts, preliminary ~~to~~ ^{proper} to the description of the improvements, ~~proper~~. There are twenty-seven such counts, or, what are technically known as, statements of invention; and after having stated the invention in twenty-seven counts the patentee says, on page 4, lines 83-88:

"The invention further comprises certain special constructions, combinations, and arrangements of parts, as hereinafter set forth, among which are included the combination, in one machine, of the several improvements already indicated, or of two or more of them."

The statement of invention with which we are here concerned is the 19th, found in the patent on page 3, lines 55 to 80, and it is necessary that it be here quoted, in order to understand the subject-matter of claim 44. This 19th statement of invention reads as follows:

Nineteenth. In transmitting the vibrations to the diaphragm it is found that with a rigid connection between the record and the diaphragm pronounced foreign vibrations are impressed upon the diaphragm or its substitute, producing scratching noises. These foreign noises can be lessened without-diminishing the reproduced speech to the same extent by the interposition of a flat metal spring in such a way that while serving as the

means of communicating vibrations to the diaphragm it can be bent independently. It is probable that this spring absorbs the vibrations which produce the scratching noises to the greatest extent, because they are more minute and rapid than speech-vibrations. Heretofore a section of rubber tubing has been interposed between the style and diaphragm; but it cannot be made as delicate as a metal spring, and for other reasons, also, is not so advantageous. For example, it is believed that it does not transmit the true vibrations of the record with as much clearness, the rubber loses its elasticity after a short time, and the tubular form of spring is less compact and less easily secured in place."

The information conveyed by this statement of invention is supplemented by the description proper on page 6, lines 66-103, and again in that part of the description which extends from line 113-on page 7 to page 8 line 17. There are several constructions shown which correspond to this description, more or less. One of these constructions is shown in Fig. 4; another in Fig. 11; ^{another in Fig. 13;} still another in Fig. 15, and still another in Fig. 17. I must confess that I am not quite clear whether by his statement of invention the patentee means to cover all these constructions, but it seems to me that only the constructions shown in Figures 4 ~~and 11~~ 11, and 13, can fairly be said to be covered by the statement of invention.

Referring to that statement, which I have above quoted, it will be seen that the patentee was aware of the fact that before his invention there had been interposed between a reproducing style and the diaphragm, a short piece of rubber tubing, so that the vibrations of the style ~~were~~ caused a compression and dilation of the rubber tubing, and these compress-

ions and dilations in turn caused the diaphragm to vibrate. This practice Mr. Tainter conceived to be a bad one, because he says the rubber tubing

"cannot be made as delicately as a metal spring, and for other reasons, also, is not so advantageous. For example, it is believed that it does not transmit the true vibrations."

Mr. Tainter therefore substitutes a flat metal spring for the ~~xxx~~ old rubber tubing, so that the vibrations of the style will cause the vibration of the flat metal spring, and the vibrations of the flat metal spring will, in turn, cause vibrations of the diaphragm. This is the way, I understand, that Mr. Tainter conceives his improvement.

When we come to look at the devices shown in the drawing, we find in Figure 4 a style 357, which receives vibratory impulses from the engraved record, transmits these impulses to a spring 395, which, in turn, conveys its vibrations to the diaphragm through the medium of a small block of ~~x~~ 363, of cork. When we look at the construction shown in Fig. 11, we find it to be precisely the same; and when we come to look at the construction shown in Fig. 13, we again find precisely the same thing, except that the interposed piece of cork is not there visible, since this figure of drawing is a perspective view and the style is not shown in co-operative relation with the diaphragm. When we look at the construction shown in Fig. 15, we find the same thing again, except that in place of the small block of cork 363, there is a small metal button 384, and of this small button the specifi-

cation says:

"This button bears upon the hard rubber diaphragm 362, and serves to communicate vibrations from the style to it."

(Page 7, lines 121-123)

therefore,
In this latter construction, it would seem that the vibrations of the style are transmitted to the diaphragm directly through the button 384, and that the spring merely participates in these vibrations; but that it cannot be said that ~~it~~ ^{the spring} transmits these vibrations. This button

"serves to communicate vibrations from the style".

to the diaphragm directly, and not by the intermediary of the spring. The latter is simply carried along, forward and backward, by the style and button.

When we come to look at Fig. 17, we again find a flat spring 391, extending parallel with the diaphragm. ~~at the~~
At its free end there is a little hole in this spring, and in the center of the diaphragm there is also a little hole, and the style, which seems to be a piece of wire, has a rounded shoulder at each end, thus forming ^{as it were,} reduced journals, ~~as it~~ ^{one} ~~were~~ at each end of the style, and these journals find their ⁱⁿ bearings in the holes of the spring and in the diaphragm. The spring presses inwardly, toward the diaphragm, and thereby keeps the style in its bearings. The ~~xxxx~~ reduced end of the style which passes through the hole in the end of the spring slightly projects through the spring, and this reduced projecting end is the one which bears upon the record. It

will be seen that in this construction again the vibrations of the style, given to it by the record, are transmitted ~~to~~ di-
rectly to the diaphragm, and not by the intermediary of the ^{these}
spring, the latter only participating in ~~these~~ vibrations.

It may therefore be said that only the constructions shown in Figs. 4, 11 and 13, embody the idea conveyed by the nineteenth statement of invention. In all the constructions shown the spring is a flat metal spring and extends ~~to~~
parallel to the face of the diaphragm.

This improvement is set forth and sought to be covered by claim 44, in these words:

"44. The combination, with the reproducer-style and the diaphragm or device upon which the reproduced sonorous vibrations are to be impressed by said style, of a flat metal spring interposed between the style and diaphragm and forming a yielding connection, through which the reproduced vibrations are transmitted, said spring having a practically rigid connection with the diaphragm, substantially as described."

This claim requires that the flat metal spring ^{shall} form ~~a~~
~~ed~~ a yielding connection between the style and diaphragm, and this condition is satisfied by the constructions shown in Figs. 4, 11 and 13. This condition, however, is not satisfied by the constructions shown in Figs. 15 and 17, since in these constructions the spring does not connect the style with the diaphragm; for in Figure 15 the connection between style and ~~diaphragm~~ is formed by the metal button 384, and in the construction shown in Fig. 17, the point of the style is connected with the diaphragm by the long extended body of the

style itself; and in both cases the spring is a simple appendix, although in Fig. 17 it might be said that ^{the} ~~the~~ spring holds the body of the style against the diaphragm. But neither in Fig. 15 nor in Fig. 17, are the vibrations of the style transmitted to the diaphragm by the springs.

A Claim 44 also requires that ^{the} ~~a~~ spring have a practically rigid connection with the diaphragm. Now the construction shown in Fig. 17 certainly does not satisfy this condition, ~~since there~~ and in Figs. 11 and 13 the connection between spring and ~~diaphragm~~ diaphragm is through a piece of cork, which can be adjusted to different positions, and which is only held in position frictionally. The only rigid connection between spring and diaphragm may be said to be found in Fig. 15.

From all this I am forced to conclude that the terms of this claim must be gathered from the different constructions shown, taking one element from one construction and another feature from another construction, etc., etc.; so that the claim is a kind of conglomerate of elements and features gathered up at random, but not found combined in any one ^{structure} ~~statute~~. In fact, the idea of the

"practically rigid connection with the diaphragm" -

is not expressed anywhere in the specification. Looking at the prior state of the art I find that the terms and the substance of claim 44 ~~is~~ are fully met in Edison's patent #200, 521 (Exhibit No. 3). In this patent I find the ~~following~~

reproducer C, having its diaphragm connected by a thread or other substance capable of conveying the movements of the diaphragm, with a spring, a flat spring, extending parallel with the diaphragm; and this spring carries at its free point the reproducing style. Here we have the style connected with a flat spring, and the flat spring connected with the diaphragm by a thread. All this is very clearly shown in Fig. 1, and is very clearly described in the specification.

The patentee says:

"In front of this diaphragm is a light spring, D, having a small point shorter and finer than the indenting point on the diaphragm of B. This spring and point are so arranged as to fall exactly into the path of all the indentations. This spring is connected to the diaphragm F of C by a thread or other substance capable of conveying the movements of D."

Here we have a style, a flat spring, interposed between the style and the diaphragm and forming a yielding connection between the two, just as called for by claim 44 of Patent 341,288, in suit. But the spring is in this case not rigidly or practically rigidly connected with the diaphragm. Mr. Edison, however, after having said what I have above quoted, continues:

.... "Now, when the cylinder is allowed to rotate, the spring D is set in motion by each indentation corresponding to its depth and length. This motion is conveyed to the diaphragm either by vibrations through a thread or directly by connecting the spring to the diaphragm F,"

This means that the thread, which in the drawing is shown as a connection between the spring and the diaphragm,

may be dispensed with, and that the spring may be directly connected ~~with~~^{to} the diaphragm. This would form the rigid connection ~~with~~ or "practically rigid connection" called for by claim 44.

This, in my estimation, shows that so far as the subject-matter of claim 44 is concerned, Mr. Tainter was anticipated by Mr. Edison. I may also refer to an illustrated article in Nature, Defendants Exhibit No. 20. The article is entitled "The Phonograph" and is found in the issue of "Nature" for July 4th 1878, on page 249 thereof. In this article is shown a reproducing diaphragm and style. The style in this case is at the end of a flat spring extending parallel to the diaphragm, and this spring is connected with the center of the diaphragm by a small rod of light pine wood. It is true that a rubber pad is at each end of the pine wood rod, but, in my estimation, the rod still forms a practically rigid connection between the spring and the diaphragm; certainly quite rigid as ~~xxix~~^a connection as the small block 363 of cork, which forms the "practically rigid connection" in Figs. 4 and 11 of the Tainter patent 341,288.

The patent to Tainter #375,579 professes to be for certain improvements upon the apparatus described in the Tainter patent No. 341,288. Quite a number of improvements are described, and one of these improvements refers to the reproducing style. This style is made in the form of a bell-^{is} crank lever. The long~~ex~~ arm of this lever ~~has~~ formed at its free end into a style, while the short arm of the lever-style is connected with the diaphragm by a thread. This is clearly

shown in Figure V. The description of this construction is found in the patent on page 5, lines ~~xxx~~ 57-97, together with the function which it performs. The specification then continues as follows:

"One advantage of using a lever as the reproducing-style is that by making the inner arm shorter than the outer, as shown in the drawings, the motion of the diaphragm can be reduced, which, though it involves a slight loss in loudness, is found to produce a more than compensating gain in distinctness of enunciation."

There is really another advantage due to a bell-crank-lever form of style in the construction shown in this patent, which is not referred ^{to} in the passage which I have here quoted, and this advantage is that by this construction the diaphragm need not be placed parallel with the surface of the record tablet, but may be placed with its plane at right angles thereto, as shown in Figure V. This advantage, however, would only ~~be~~ ~~the~~ result from a bell-crank lever, and not from every kind of lever. It is therefore true that the advantage of a lever, generally, is that the motion of the reproducing diaphragm can be made smaller than the motion of the style point.

Now I find that this idea is expressed quite clearly in the Edison patent No. 227,679 of May 18, 1880, Defendants Exhibit No. 6. In Figs. 5 and 6 of that patent there are shown recording and reproducing diaphragms and styles, and the styles are in both cases formed on or mounted on levers. In Fig. 5, the style is on the free end of the lever, and the diaphragm is connected with the lever at a point intermediate

between its pivot and free end. In this construction, ^{when} ~~it~~ it is used as a reproducer, the amplitudes of vibrations of the diaphragm will be smaller than those of the style.

In Figure 6, the diaphragm is connected with what might be called the free end of the lever, and the style is midway between the two ends of the lever. Consequently, with this construction, if it is used as a reproducer, the amplitudes of vibration of the ~~diaphragm~~ diaphragm will be greater than those of the style. Mr. Edison evidently believed, ~~that~~ when he filed his application on March 29 1879, that he was the first inventor of the reducing or magnifying lever in connection with phonographs. He says, in the paragraph extending from page 1, line 90 to page 2, line 7:

"Another feature of invention relates to a lever between the diaphragm and the phonogram, whereby the relative movements of the parts may be varied. This lever e has a fulcrum at 15. If the connection to the diaphragm is between the point D and fulcrum 15, as in Fig. 5, then the motion of the point will be greater than the diaphragm, and when used in the phonograph will amplify the indentations in the foil. If used in the phonet, the movement of the diaphragm would be lessened. I therefor prefer, in that instrument, to change the places of the point and diaphragm connection, as shown in Fig. 6, so as to amplify the movement of the diaphragm and increase the sound."

. Mr. Edison also broadly claims this improvement as follows:

"4th. The combination, in a phonograph or phonet, of a diaphragm, a point, and a lever intervening between the diaphragm and the point, substantially as set forth."

It is true that Mr. Edison does not show or describe a bell-crank lever having the end of one of its arms formed into a style; nor does he describe his style and lever as being in one piece; and it may be that such construction ~~is~~ was new with Mr. Tainter and may, perchance, be patentable. But Mr. Tainter claims his construction in much broader terms than he describes it; he claims it as follows:

"20. The combination, with the diaphragm of the reproducer, of the rubbing-style consisting of a lever having the rubbing point formed on one arm and the other connected with said diaphragm, substantially as described."

It will be seen from this that while this claim is restricted to ~~a style a~~ a

~~"formed on one arm"~~

"rubbing-style consisting of a lever having the rubbing-point formed on one arm"—

that is ~~to say~~, to say, to a lever and style formed in one piece; it is not restricted to a bell-crank lever. If this restriction were read into the claim it could not be said that it would then be met by the Edison patent. But without this restriction it certainly is ~~not~~ met by this Edison patent, since I do not believe that the fact that Edison does not ^{de}scribe his lever and style as being formed in one piece can make a patentable difference. Edison's style is, if not made in one piece with the lever, certainly fixed to it; and this serves the same purpose, precisely.

I conclude from all this, that, as respects the subject matter of claim 20, the Tainter patent #375,579 marks

no invention over the prior state of the art and that the claim is fully anticipated by the Edison patent #227,679.

Adjourned until Tuesday, January 10th 1900, at 11 A.M.)

Washington, D.C., January 10th 1900.

Met pursuant to adjournment.

Present- Counsel as before.

Q.9- Are you familiar with the commercial Gramophone as the same is represented by Complainants Exhibit, Defendants Machine; and are you familiar with the history of the development of the Gramophone?

A- I think I may claim intimate knowledge of the commercial Gramophone as represented by Complainants Exhibit Defendants Machine; also with the processes of making sound records adapted and intended ^{for use} ~~to produce~~ with this machine. I may also claim intimate knowledge of the history of development of the Gramophone.

The inventor of the gramophone, Mr. Emile Berliner, was in the habit of communicating to me from time to time all that he did in the development of this art, and I was invited by him, on numerous occasions, to witness his experiments and ~~participate~~

participate in them.

was

I ~~was~~ also Mr. Berliner's patent solicitor in connection with the various applications for patent which he filed for his inventions in this art.

Q.10- Please , now, give an exposition of the development of the Gramophone by Mr. Berliner, and state the relation of the same to the prior state of the art?

A- Early in the Spring of the year 1887 I was already well acquainted with Mr. Berliner. At that time I had known him by report for ten years, and personally for a number of years. Either in March or in April 1887, Mr. Berliner invited me to his house, and there showed me a flat metal plate, having on its surface a number of undulatory grooves of apparently even depth; and this plate, Mr. Berliner said, he had obtained by making ~~an~~ photoengraving of a phonautographic record, which he had produced upon a sheet of paper. He showed me the sheet of paper, and I recognized at a glance that it was an ordinary phonautographic record sheet. Mr. Berliner, moreover, showed me the cylinder upon which he had made the phonautographic record. The sheet of paper had been wrapped around the cylinder; had been exposed to a smoky flame, and had received the writing of ~~the~~^a style secured to a vibratory diaphragm, against which Mr. Berliner had uttered a few words, and may be other sounds. All this was so familiar to me that I really understood the whole procedure as soon as I saw the phonautographic record.

The photo-engraving of the phonautographic record ~~is~~^{was} a rather coarse affair, but it showed the undulatory grooves of even depth very plainly, and rather far apart, in practically parallel lines. Mr. Berliner, at that time, told me that he would pursue his investigations and hoped that he would eventually be able to make photo-engraved phonautographic records from which very loud reproduction of the recorded sounds would be obtained. He explained that, unlike the process pursued by Edison and by Bell & Tainter, his process, the phonautographic process, does not impose upon the recording style ~~an~~^{an} appreciable work. The film of lamp black, so Mr. Berliner said, was so infinitesimally thin, that it required no appreciable work to draw a line upon it that is clearly visible to the unaided eye. Since the recording style had to do practically no work, Mr. Berliner expected that the sounds would be recorded much more faithfully and with much greater amplitude than by the indenting or engraving process. In addition thereto Mr. Berliner pointed with some pride at the photo-engraved copy of the sound record, saying, that it constituted an indestructible, or practically indestructible, record, which need not be handled with care and delicacy and need not, like the Bell and Tainter wax record, be preserved in ~~the~~ ~~the~~ ~~the~~ a refrigerator during ~~the~~ hot weather.

Mr. Berliner then proceeded to reproduce the sounds recorded on the metal plate, and he did this by taking hold of ~~a~~^a head having a diaphragm and reproducing style mounted thereon, and drawing the same over the metal plate, with the

style point in engagement with a record groove. This gave a kind of reproduction; that is to say, there issued from the diaphragm either a word or two, or a short whistle, according to what happened to be recorded in that particular groove. Since the grooves were parallel to each other and not continuously connected, each groove had to be used separately; ^{the first} so that, beginning with ~~any~~ groove, and following up the others in intermittent succession, the words or other sounds issuing from the diaphragm were disconnected, but quite intelligible, shouts.

These shouts were very loud, very much louder than any sounds I had yet heard issuing from the reproducer of either an Edison Phonograph or a Bell & Tainter ~~Gramophone~~ Graphophone. At the same time, however, there were harsh foreign sounds superimposed upon the recorded sounds, and at that time Mr. Berliner ascribed the presence of these foreign disturbing sounds mainly to the fact that he had no means of moving the tablet or the style regularly and uniformly.

Mr. Berliner then substituted for the reproducing diaphragm and style, a stick of bamboo, pointed at one end. He inserted the point of the bamboo stick into the grooves, and moved it along and through the grooves ^{the same} as he had done with the style of the diaphragm-reproducer. This also gave quite audible reproduction, although very much fainter than when the diaphragm and style were used; and, moreover, the sounds thus obtained, were remarkably free of foreign disturbing noises.

At that time I was familiar with the Lambrigot Six-Penny Phonograph (Defendants Exhibit No.19), and I could not help noticing the similarity of the mode of reproduction by Mr.Berliner, with the mode of reproduction described in the Lambrigot article. In both cases the reproducer was drawn by hand over the tablet. But while in the Lambrigot arrangement considerable skill would be required to draw the edge of the disk over the elevations and depressions which there constituted the record, without sliding off and thus missing the record; no such skill was required in Mr.Berliner's practice. Once he had inserted the style in the groove, he could ~~basily~~ ^{boldly} draw it along the groove, without precaution or care, and without missing a sound.

I made some remarks about this facility of reproducing, and Mr.Berliner explained that this was not a matter that ~~would~~ ^{should} cause surprise, since with his record it was of no consequence how the style was inserted in the groove, and whether it was pressed into it hard or lightly, or not at all. He said that, since with his laterally undulating record the bottom of the groove had nothing to do with the reproduction of the recorded sounds, all that was necessary was that the style be in the groove, somehow or other, and that it was not necessary to look for any particular portion of the groove. The side walls, which alone acted upon the style to vibrate the same, would always be there, and would always find the style to act upon it, pushing it now one way and now the other.

The conversation which I had on that occasion with Mr. Berliner was quite lengthy, and Mr. Berliner said that he believed that he now had within his grasp an entirely new process of recording and reproducing sounds.

In the same year, sometime in May or June, and possibly in July, Mr. Berliner told me that he had made what he considered a great improvement upon his method of recording sounds; in fact that he had made two improvements, each of which greatly improved the character of the record produced. One of these improvements was ~~that~~, instead of making the phonautographic record upon a sheet of paper wrapped upon a cylinder, to make it upon a circular disk of glass, which would diminish the friction between the recording style and the tablet, and which would also enable him to make a better photo-engraving therefrom. The other improvement, which he considered the more important, was to convert the lamp-black deposit on the glass into an ~~amorphous~~ amorphous ink, before the phonautographic record was made upon it. He had noticed that the zig-zag lines drawn by the style upon the smoked surface were not by any means as smooth as they looked to the unaided eye. When observed through a magnifying glass the edges of these lines revealed great unevenness, due to the flocculent ~~fluctuant~~ character of the sublimated smoke, the lamp black. In other words, lamp black is not a structureless body, but a body composed of an infinite number of small flakes, which are very loosely held together. Now, so Mr. Berliner said, when the style draws a line upon such surface it pushes these flakes

flakes to the right and to the left, and forwardly, and behind the style they again fall into the trace left by the style, ^{and} project~~ing~~ beyond the edges of the line, giving to the latter a saw-tooth appearance. When such phonautographic record is ^{copied} ~~reproduced~~ in metal by photo-engraving, all these innumerable saw teeth are ^{also} ~~also reproduced~~ faithfully ~~reproduced~~ copied, and when the recorded sounds are reproduced, the style ~~the~~ style is not only actuated by the lateral undulations, but also by the saw teeth, and thus the foreign scratching noises are imposed upon the reproduced sounds.

He had observed, so Mr. Berliner said, that those portions of the phonautographic record which were drawn through a lamp black deposit derived from a flame that was held much nearer to the tablet than ordinarily, had less of a saw tooth appearance, and he concluded that this was due to the fact that in such cases the oil or fat which was being burned had not all been converted into lamp black, but had been carried upon the tablet in an unburned condition, and had mixed with the lamp black proper and converted the same into a kind of printer's ink, that is, into a mixture of lamp black with oil. Mr. Berliner then said that he had made such printer's ink artificially, by first smoking the glass disk which he used at that time, and then blowing over it an exceedingly fine spray of oil. This oil, he said, instantly mixed with the lamp black, and made of it an amorphous ink; and this ink would give a very sharp line, practically free of saw teeth..

Mr. Berliner showed me at that time the ~~en~~-glass disk with a phonautographic record on it through a film of amorphous ink produced in the manner I have stated; and he also showed me a photo-engraving made from the same. In this case the record was along a spiral line on the disk, and Mr. Berliner had a turn table by which the metallic tablet was rotated and ~~again~~ the recorded sounds were reproduced by holding the reproducer head in the hand, while the tablet was being rotated. The reproduction was very good, the sounds being largely free of disturbing noises.

On Thanksgiving Day of the same year (1887) I met Mr. Berliner by appointment at his house, together with Mr. John W. Osborne and Mr. Werner Suess. Both gentlemen had been invited by Mr. Berliner, Mr. Osborne upon my suggestion, to discuss ~~and to examine with respect to~~ the new method of recording and reproducing sounds. Mr. Osborne is the inventor of the photolithographic process which is practiced today all over the world, and Mr. Berliner hoped to obtain from him some valuable hints as respects the best method of photoengraving. Both Mr. Osborne and Mr. Suess are physicists, and ~~evinced~~ great interest in this matter. The interest was a purely a scientific one. On this occasion Mr. Berliner again displayed a metallic record disk made from an original glass record, and the reproduction was again practiced by holding the reproducer in one hand and rotating the table by the other hand. The old bamboo stick reproducer was also used on that occasion.

Late in the year 1887, certainly after Thanksgiving Day, Mr. Berliner showed me a metallic record ~~groove~~ which

he had made by an etching process, which I will call the process of indirect etching. It had been made in the following manner:

A Phonautographic record was first made on glass through a film of amorphous ink, produced in the manner which I have already described. From this phonautographic record a photographic negative was made, and this negative was put in contact with a zinc plate that had first been covered with a film of bichromated albumen, and the whole was then exposed to light. The portions of the negative which represented the sinuous line corresponding to sound waves were opaque, and, consequently, corresponding portions of the bichromated albumen were not affected by light. After this the ^{zinc} plate was washed and thereby the non-exposed portions, namely- the undulatory line, was ~~thus~~ removed, while the spaces between the lines remained, having been rendered insoluble in water ~~and~~ by the action of light. Mr. Berliner thus had obtained a ~~pl~~ zinc plate covered with insoluble bichromated albumen, with an undulatory spiral line representing sound waves removed, and showing the zinc background. This plate, after having its edge and back protected, was placed in diluted nitric acid, which etched into the plate where it was not protected by the insoluble bichromated albumen, and thus produced an undulatory ^{groove} ~~line~~ of even depth.

This was the first etched zinc record of recorded sounds that I saw. Mr. Berliner told me that he had closely examined that record by the ~~microscope~~ microscope, and he invited me to do the same thing. This I did, and I found that

some portions of the groove were exceedingly sharp and clean, while others were only imperfectly etched and rough. By rough, I here mean that the groove showed a decided grain; it was coarsely granulated, and at such points the groove also seemed to be shallower. Tolerably good reproduction was obtained from this plate, or, rather from some portions of it. The trouble which was experienced was mainly the difficulty of tracking the groove. This groove was in some parts of the plate so shallow that the style would ~~x~~ jump out of it; The walls of the groove were not steep enough to hold the style in the groove.

I suggested at that time that this difficulty would not occur when a complete machine was built in which either the record plate or the style would, by suitable gearing, be propelled in the line of a diameter of the plate. Mr. Berliner replied that this was probably true, but that he should like to dispense with any gearing, and should like to have the record itself propel the style across the plate; since only in this manner would it be possible to make ^a ~~it~~ cheap machine, and one that could not get out of order. Mr Berliner said that if one part of the groove can propel the style ~~x~~ across the plate, then it must be possible to make all parts of the groove so that ^{they} ~~it~~ will safely perform the same function.

The unevenness of depth and the granulation of some portions of the groove Mr. Berliner explained by the appearance of gas ^{bubbles} ~~burners~~ when the plate was in the etching bath. These gas ^{bubbles} ~~burners~~, he said, would, as it were, stick to the

initial groove, and ~~prevented~~ ~~it~~ prevented the continued access of the etching fluid thereto.

Altogether, Mr. Berliner was less satisfied with his etching process than I was; he was also dissatisfied with the use of the glass disk, and with the cumbersome ~~paraphernalia~~ ^{paraphernalia} required until the zinc plate could be placed into the etching bath. He was particularly dissatisfied with the use of lamp-black ink, since he found that even this would sometimes give ragged edges to the traced record line, on account of its comparative brittleness when it had been ^{dried} ~~dry~~ before the record was inscribed.

Early in 1888, probably in February, Mr. Berliner started a new scheme; he entirely abandoned the use of a glass disk and the process ^{of} ~~in~~ direct etching which I have described, and attempted to trace the phonautographic record line directly upon a zinc plate. For this purpose he covered the polished surface of a zinc plate with a solution which he obtained by dissolving bees-wax in ~~benzine~~ benzine. The benzine would dissolve only some portions of the bees-wax, leaving a residue which would not at all dissolve in benzine. Bees-wax is an exceedingly complex body, so that it appears that Mr. Berliner obtained in this manner only the solution of one of the constituents of bees wax in benzine. This gave an exceedingly thin and ~~an~~ exceedingly soft film upon the zinc plate, and through this film he traced the phonautographic record ^{in the manner in which} ~~(the same)~~ ~~as~~ he had before traced such a record through a film of lamp black, and subsequently through a film of ink.

The ease with which a phonautographic ⁱⁿ~~an~~scription was made upon a plate thus prepared, was quite astonishing. The film obtained from the solution of bees-wax in benzine was so exceedingly thin and non-resisting, that the style, in tracing the line, had practically to do no other work than that of overcoming the friction between it and the zinc surface. ~~A plate thus~~ The plate thus prepared and inscribed was placed in a bath of diluted nitric acid, but the etching thus obtained displayed the same unevenness and ~~some~~ roughness ~~at the edges~~ as Mr. Berliner had obtained by his former, indirect etching with nitric acid. . Mr. Berliner knew that the gas bubbles which caused the roughness and inequality of depth of the grooves must be bubbles of hydrogen gas, and he knew that chromic acid, which in a variety of forms is used in electric batteries as a depolarizer, would tend to ~~absorb~~ destroy these ~~bubbles~~ bubbles. He therefore mixed some bi-chromate of ~~soda~~ soda with the nitric acid, and at once obtained very much better results; ~~the~~ gas bubbles disappeared altogether; but he found that the exceedingly thin film of one of the constituents of wax did not safely protect the whole surface of the plate against the attacks of this etching fluid. He would thus sometimes find that while the record line was well etched, the parts between the lines were also etched, more or less, and sometimes this subsidiary etching would run into the primary etching and disfigure the same. He then abandon^d nitric acid, and used chromic acid, properly diluted, and this gave much better results, but also

had its difficulties. Finally, Mr. Berliner used ordinary battery fluid, namely- a mixture of sulphuric acid and bichromate of potash, and this gave him excellent results ^{when} ~~if~~ the mixture was used immediately after it had been prepared. When, however, this mixture was allowed to remain unused, even ^{unused} for a few hours, and more so if ~~was~~ ~~was~~ for a day or two, the results obtained were uncertain. The reason for this uncertainty was that the bichromate of potash would crystallize out of the solution and would leave the solution impoverished. Mr. Berliner then substituted bichromate of soda for the bichromate of potash, and thereby all troubles arising from the etching fluid were removed; for bichromate of soda does not crystallize out of its solution in sulphuric acid.

In this manner Mr. Berliner made a great number of zinc record plates, and some of them were excellent, while others displayed peculiar defects, for the appearance of which no theory would give an adequate explanation for a long time. The defect was this:

Instead of obtaining a single well defined record groove, there sometimes appeared two and three grooves very close together, and partly running into each other; it was a bundle of grooves instead of a single groove. In this bundle of grooves there would always be one groove a little more defined than the others that constituted ~~a~~ the bundle; but the reproducing style would sometimes take its path through the main groove and sometimes through the less well defined

grooves, and altogether reproduction became uncertain whenever such bundles of grooves appeared.

After long and tedious trials, under a variety of conditions of making the record, Mr. Berliner came to the conclusion that it could not be the style that made a bundle of grooves instead of a single groove, but that there must be some foreign body or bodies accompanying ~~the movement of~~ ^{in its movements,} the style and which were sufficiently rigid to penetrate the waxy film. He finally found that this was really so; that some fibrous, extremely small bodies, suspended in the air, would deposit upon the waxy film, and these fibres, being dragged along by the style ~~and~~ scratch the waxy film deep enough to allow the etching fluid to act upon the underlying zinc.

A long series of experiments were made to overcome this difficulty. Mr. Berliner first tried to purify the ambient air by charging it with water, expecting that the floating films would, in this manner, either be deposited upon surrounding objects, as the walls of the room, or that they might, perhaps, be so tenaciously held by the moist air as not to deposit upon external objects, and thus not deposit upon the waxy film. A room was made scrupulously clean and the air was heavily charged with sprays of water. The waxy film was deposited upon the zinc immediately before it was used. In this manner the records were really ~~very~~ improved a little; but still the bundle of lines would occasionally again make their appearance and thus render the process a matter of great uncertainty. It must be remembered that by that time Mr. Berliner had become very critical as respects

the character of the sound record which he obtained. What would have satisfied him at an early period of his work did not satisfy him now, and still he found himself assailed by an invisible foe, by particles floating in the air ^{and} of which he could not rid himself. Finally the idea occurred to Mr. Berliner that if he protected his waxy film against the access of air, he would get rid of the floating particles, and he discussed with me ~~the possibility~~ in a bitter, though ^{humorous} ~~humorous~~ fashion, the absurdity of being called upon to record sound waves in a vacuum.

At last, however, Mr. Berliner conceived a method of ^{access} protecting the waxy film against the ~~access~~ of air without having recourse to a vacuum. He covered the zinc plate with its waxy film with a layer of alcohol, while the record was being inscribed thereon; and this gave him a single, sharp, well defined record line, with no trace of accompanying bundles of lines. Mr. Berliner thought at that time, and I certainly thought, that all difficulties had now been overcome. Another trouble, however, made its appearance, and this was that when a plate thus treated was ~~then~~ put into the etching fluid, it would ~~fail~~ not be etched uniformly; that is to say, some portions the record line would be etched only very shallow, while other portions would be etched exceedingly well. There was, however, in this case, no roughness in the etching, but on the contrary, the shallow and thus imperfect grooves were, if anything, brighter than the deeper ones. Evidently then there were no gas bubbles that caused this new trouble. ~~and in fact~~

and in fact no such bubbles could be observed. How, and by what process of reasoning, Mr. Berliner finally discovered the cause of this inequality of the etching which was certainly not caused by gas bubbles, I cannot say.

(Adjourned until Thursday, January 11th 1900, at 11 A.M.)

Washington, D.C., January ~~12th~~ 11th 1900.

Met pursuant to adjournment.

Present- Counsel as before.

Mr. Lyons continues his answer to Q.10.

A- The cause of the unevenness of etching a zinc plate covered by a film of waxy material, when the record line was traced through the film ~~with~~ under conditions where the access of air was excluded, that is to say, while the film was covered with alcohol, Mr. Berliner found to be that the alcohol would partly dissolve small portions of the waxy film, so that when the tracing of the record was completed the alcohol retained in solution an extremely small quantity of wax, or one of its constituents. When, then, the plate was taken from the recording machine, out of the alcohol, the small film of alcohol which adhered to it would quickly evaporate, and in thus evaporating would deposit upon the plate and therefore also upon the lines which had been laid bare by the

style and almost infinitesimally thin film of waxy material. This means that the sinuous line made by the style had not now any more a clean metallic surface, but had a surface of waxy material. This ^{deposited} waxy material in these lines was so extremely thin that it could not be detected by visual observation. In fact the lines looked as if they were purely metallic; but from the nature of things they could not be purely metallic, since the alcohol which had covered them must have had traces of waxy material in it, and ^{these} ~~this~~ would unquestionably, and beyond doubt, deposit upon the line when the alcohol evaporated. Alcohol is a very poor solvent of wax or its fatty acids; but it dissolves a little of it, and although the quantity it is capable of dissolving is extremely small, Mr. Berliner concluded that it must be that small quantity of dissolved and afterwards deposited fatty acid, which prevented the etching fluid from acting upon the traced lines as vigorously as it would if the lines had ^a pure metallic surface. Now, Mr. Berliner concluded, that since the quantity of alcohol adhering to the plate when the same was removed from the recording machine, would not be evenly distributed all over the plate, but ^{would form} ~~would form~~ a little thicker layer at one place than at another; ~~and consequently~~ ^{that} the re-deposited fatty film would be thicker at one place than at another. If Mr. Berliner's theory was correct, then this would account for the unevenness of depth of the etching obtained; and if the alcohol could be removed from the plate before it had a chance to deposit the waxy material it held in solution, all

trouble would be avoided. Upon this theory Mr. Berliner went to work, and he removed the alcohol adhering to the plate when the same was removed from the recording machine, immediately, by running a stream of water over it. As soon as he had done this, he obtained an excellent etching of even depth, and he had thus removed every trouble, every difficulty that he had had to contend with.

I have here attempted to give every step in the development of Mr. Berliner's process of recording sounds by making the sound waves inscribed an undulatory line, and then copy such line in metal; but I am by no means certain that I have not omitted to speak of some of the difficulties which had to be overcome until the successful result was obtained. I will here say that I have followed up Mr. Berliner's work in this line from the early part of 1887 until its successful accomplishment; that I was in constant communication with Mr. Berliner; that I received his disclosures sometimes from day to day; sometimes from week to week, and sometimes at longer intervals. I participated in many of the experiments which Mr. Berliner made, and I spent many an evening with him in the discussion of experiments made and others that he planned. In this manner I think I learned what it means to make a phonautographic record through an etching ground placed upon a metallic disk, and to etch that record so as to be an undulatory groove of even depth. I believe that I know and appreciate, better than ~~some other persons~~ I did in the early part of 1887, what experiments and inventing ^{is required} ~~has~~ to bridge the gap between the proposition to make such a record

and
 the act of successfully making it; and I will here say, that,
 in my estimation, the step from the proposition to the successful performance of the work marks a series of brilliant inventions.

The essential steps which led up to the perfected sound record in a metal plate are set forth in Mr. Berliner's patent #372,786, dated November 8th 1897; in his patent #564,586, dated July 28th 1896, (Application filed November 7th 1887) and in his patent #534,543, and I may have occasion again to refer to these patents.

Mr. Cameron, testifying in this case in behalf of complainant, when he comes to consider the production of a metal plate having in its surface an undulatory groove of even depth representing sound waves, by Mr. Berliner, finds that this whole thing was old, very old and well known, before Mr. Berliner entered the field. He finds, to his own satisfaction, that nothing remained to be done for Mr. Berliner; that all he had to do in order to obtain his metallic record, was to simply do what those that preceded him in this art said ~~that it~~ must be done. Mr. Cameron first approaches this subject in his answer to Question 5, where ~~he~~ he quotes in full the paper which Mr. Cros had deposited with the French Academy of Science in 1877, and where he also quotes from the Cros French patent #124,214, dated May 1st 1878. After having done this Mr. Cameron says:

"It thus appears that as early as 1878 there were two well known forms of sound records, viz: the zig-zag record of even depth, as in the Cros etched or photo-engraved record;

and the one of uneven depth with vertical undulations, as in the Edison tin foil record."

Further on in the same answer Mr. Cameron says:

"But Bell & Tainter were well aware that there were: 'other forms of record' (such as the Cros etched zig-zag record for example) which might usefully be employed...."

Listening to this language one would suppose that Mr. Cameron had either seen, or heard somebody say that he had seen a record made by Cros, or under his instructions by somebody else; or one might suppose that he had been informed by Messrs. Bell & Tainter that they had either made or had seen a record made in accordance with Mr. Cros's instructions. The fact, however, is that Mr. Cameron had never seen such a record, and had never heard anybody say that he had seen it, and had never read a statement from any source to the effect that such a record had ever been made. He says in the same answer to Q.5:

".....and so far as I am aware Cros never actually constructed the devices described in his French patent."

How, under such circumstances, Mr. Cameron could confidently say that in 1878 ~~an was~~ a record consisting of an ^{groove} plate having in its surface an undulatory ~~line~~ of even depth was well known; and how he could confidently say that Messrs Bell and Tainter, when they wrote the specification of their patent #241,214, were well aware of the existence of such a

record, I do not understand. I certainly should not feel warranted in making such statements upon such information. Mr. Cros had said in his sealed paper that a phonautographic record made upon a blackened surface may be copied in resisting material; and he says it in these words; which Mr. Cameron quotes:

"By means of the photographic process, which, in fact, is well known, this traced, transparent, undulatory spiral is converted into a line of similar dimensions, in intaglio or in relief, in resisting material like tempered steel, for instance."

This is all Mr. Cros says on this subject.

Now, Mr. Cameron has never tried to do what Mr. Cros suggested, and I am confident that if ^{he} ~~Mr. Cameron~~ attempted to do it, he would utterly fail. I am bold to say that I do not believe that anybody ever attempted to copy a phonautographic record in tempered steel by photo-engraving, and I do not believe that if it were attempted it would succeed. Mr. Berliner produced a ~~xxxx~~ photoengraved copy of a phonautographic record, but he produced it in a much softer metal; he produced it in type-metal, and he found that it was by no means easy to make it. So far as the history of this art is disclosed in printed publications, Mr. Berliner appears to have been the first who ever made such a record. Mr. Cros had spoken about making one, but so far as we know, so far as Mr. Cameron knows, he never did it, and nobody else ever did it except Mr. Berliner. I conclude from this that Mr. Cameron is mistaken; that a sound record made by the pro-

cess of photo-engraving was not known in 1878.

In his patent Mr. Cros suggests the etching method for copying phonautographic records. He says this in these words, which Mr. Cameron quotes:

"The lamp-black may be replaced by a body insulating an underlying metallic plate from the engraving action of an acid. In this case the work of the ~~stylus~~ stylus is increased by the cohesion of the insulating substance.

Tallow, paraffine, the varnish of aquae fortis can serve."

I have hereinbefore characterized this suggestion, and now, since I have given my experience as respects the many failures with which Mr. Berliner met when he attempted to make an etched record, I may add that no person skilled in this art would learn anything that is of value from Mr. Cros's suggestion. Mr. Cros suggests as etching grounds, -

"tallow, paraffine, the varnish of aquae fortis"

and he recognizes that in this manner

"the work of the stylus is increased by the cohesion of the insulating substance."

This is very ~~true~~ true, and it must be said that Mr. Cros was wise enough to recognize the fact that it might be difficult to trace sound vibrations through any of these materials. What he did not recognize was that it is impossible to trace sound records through such materials if employed in etching the fashion in which ~~etching~~ grounds are commonly employed in the general art of etching. In order that a sound recording style may penetrate all through an etching ground, that

ground must be so extremely light that it offers practically no resistance to the style. How to make an etching ground so light, and yet make it protect the plate against the action of an etching fluid, is something that, to my knowledge, nobody has ever attempted to find out before Mr. Berliner approached the problem; and if somebody attempted this he, in all probability, failed, since we have no record of such a successful attempt.

I know two gentlemen of unquestionable ability; of great skill and high attainments in the art of recording and reproducing sounds; and I was informed by one of them that they jointly attempted to record sounds through an etching ground and then etched a plate; and I have been informed by this gentleman that their attempts failed utterly, because the style would not pass through the etching ground. The two gentlemen of whom I speak ~~xxx~~ are Mr. C. A. Bell and Mr. S. Tainter, the same to whom patent #241,214 here in suit was granted; and the gentleman who gave me the information I speak of is Mr. S. Tainter. The prediction, therefore, of Mr. Cros, that the work of the stylus would be increased by the cohesion of ~~the etching ground~~ the etching ground, was ~~xxx~~ verified by the experience of Messrs. Bell and Tainter. ~~and it was verified~~

I have already pointed out that I do not know, and that I cannot conceive, what Mr. Cros means by suggesting "the varnish of aquae fortis" as an etching ground. Such varnish seems to be an impossible thing.

From all this I conclude that neither the photo-engraved nor the etched record were known in 1878, except in the nature of a scheme, or ^{as} ~~of~~ something of which it ^{was} ~~is~~ hoped that the future may realize.

As to Messrs. Bell and Tainter 's knowledge of a laterally undulating record groove of even depth, ^{produced} ~~xxxxxx~~ in any other manner than by etching, at the time ~~of~~ when they wrote their specification for patent No. 241,214, Mr. Cameron says that such knowledge is proved by a sealed paper which these gentlemen deposited in the Smithsonian Institution on October 20th 1881. Knowledge of such paper and its contents Mr. Cameron professes to have obtained from the record of a suit of the American Graphophone Company against the United States Phonograph Company et al. in the Circuit Court of the United States for the District of New Jersey. According to Mr. Cameron the contents of that sealed paper appeared in the testimony taken in that case during the years 1895, 1896, etc. I have no other knowledge of that paper than ^{the information} ~~that~~ furnished by Mr. Cameron in his answers to X.Qs. 34, 35 and 36; and from Mr. Cameron's answer to X.Q. 37 it seems that all the knowledge he has of that paper he derived from the record in the suit to which I have referred. I can therefore speak of that sealed paper and its contents only from the information furnished by Mr. Cameron in this case. From the contents of the reputed sealed paper of October 20th 1881 Mr. Cameron, in his answer to X.Q. 34, quotes the following:

"Our invention consists, in the first place, of a new form of phonograph, or apparatus for recording sounds by the voice; and in the second place, of a new kind of graphophone or apparatus for reproducing sound~~x~~ from a phonogram or permanent record. The phonograph consists of a flexible diaphragm, which can be thrown into vibration by the voice, and which communicates its vibrations to an engraving tool resting upon the film or coating of wax, paraffine or other similar ~~x~~ substance, on or into which the voice record is to be engraved. The end of the cutting tool presses ~~again~~x~~~~ against the prepared substance, and cuts out a groove of considerable width, as the prepared substance is moved past the end of the tool. Under these circumstances, when a person speaks against the diaphragm of the phonograph, its vibrations are communicated to the tool, so as to cause a to and fro motion of the end in contact with the prepared substance. This motion may be either in a plane parallel to the surface of the prepared substances, so as to produce a wavy or zig-zag line of uniform depth, or it may be in a plane perpendicular to the surface, so as to cut out a straight groove of varying depth, as may be desired. A phonogram of either of these kinds may be copied in more durable material by any of the well known moulding or electroplating processes; and the sound may be reproduced either from the original phonogram or from one of the copies."

From this extract from the sealed paper Mr. Cameron concludes:

"I think this very clearly demonstrates that Messrs. Bell & Tainter were acquainted with the record in the form of a wavy or zig-zag line of uniform depth....."

If speaking about ^athe thing, demonstrated knowledge of that thing, then Mr. Cameron would be right. To my mind the fact that somebody speaks of a thing, or says that he may, or might, or would, do a certain thing, is not demonstrative proof that he knows anything about the thing.

Homer tells us of Daedalus and ~~Icar~~ Icarus, father and son, as having prepared themselves a pair of wings, and as having made a flying trip in Greece. Still, the art of flying has not yet been invented, and I am not prepared to credit Homer with knowledge of this art.

The celebrated Johnathan Swift, in one of his writings, speaks of the two moons of the Planet Mars; but these moons were only seen for the first time in the year 1877 by Prof. Hall, in this city; no other ~~xxxxxx~~ human being had seen them before; and I am not prepared to credit Dean Swift with knowledge of the moons of Mars.

Jules ~~Rex~~ Verne minutely describes a submarine boat, his Nautilus; but I really do not believe that anybody would have given him a contract for the building of such boat.

Similarly, Messrs. Bell and Tainter speak of a laterally undulating record, cut into wax, and of ~~reproducing~~ copying the same in more durable material by moulding or electroplating; but to my mind this does not prove that they knew anything about it. According to my information, which I have hereinbefore given, these two gentlemen really attempted to make an etched sound record, and failed; and I really am unable to credit them with knowledge of an etched sound record.

(Adjourned until Friday January 12th 1900, at

11 A.M.)

Washington, D.C., January 12th 1900.

Met pursuant to adjournment.

Present- parties as before.

Mr. Lyons continues his answer to Question 10.

From the state of the art of recording and reproducing sounds which preceded Mr. ~~Edison~~ Berliner's efforts, and which state of the art I have hereinbefore given, it appears that a laterally undulating record was first suggested by Mr. Cros; that Mr. Edison in his United States patent #200,521 again suggested a laterally undulating record, and that finally Messrs. Bell & Tainter are said by Mr. Cameron to have spoken of such record in their sealed paper, which they had filed in the Smithsonian Institution. This is all that preceded Mr. Berliner. I have characterized before these suggestions of Cros, Edison and Bell and Tainter, and I do not hesitate in saying that they contained nothing, absolutely nothing, but the statement of a problem, with no suggestion of any practical means of solving the problem. Consequently, Mr. Berliner, if he had been acquainted with the suggestions of these parties, ^{learned} ~~he~~ could have ~~done~~ nothing ~~from~~ from them; and he is therefore not indebted ^{to} ~~in~~ the prior art.

As respects the particular method of making a sound record in metal, by etching, I think I have shown sufficiently that the mere suggestion that it be etched through wax, paraf-

fine or "aqua fortis", which was thrown out by Cros, could ^{even} not teach Mr. Berliner anything, if he had been aware of this suggestion. I know, however, that Mr. Berliner was not aware of these matters when he entered the field. I know this as well as we can know anything of the state of the mind of another person with whom we are most intimately connected, and whose unrestrained confidence we enjoy. I am therefore convinced that, as respects the process of etching a sound ⁱⁿ record ~~the~~ metal, Mr. Berliner is not indebted to the prior art.

How worthless, and, sometimes, how ridiculous, the vague suggestions of inventors or would-be inventors are, is well ~~illustrated~~ illustrated in the article in the Telegraphic Journal, Defendants Exhibit No. 18, about the Carbonel Phonograph, to which I have already referred for another purpose. In this article some experiments of ^{the} Abbé Carbonel with the indenting phonographic ~~inventing~~ process are reported; and in this article the following suggestion is thrown out:

"The foil could be made from a copper band thinly coated with wax to take the impression, and corroded afterwards by acid so as to obtain a hard metal cast."

This means that a copper band is to be coated with wax; that the wax is to receive the indentations of a style actuated by sound waves, and that these indentations are then to be etched. This suggestion is so ridiculous, that I do not believe that a person who has ^{even} ~~given~~ the remotest idea of what etching means, could read it without at once recogniz-

ing its utter absurdity. In the first place, in order to obtain any kind of etching, the indenting style would have to lay bare ~~expose~~ the copper, underlying the wax; ^{and this} ~~which~~ it cannot by any possibility do, seeing that by the indenting process no material is removed. In the second place, even ^{were} supposing that, somehow or other, the wax ~~is~~ removed along the line of indentation, the acid would have to etch to greatly different depths the successive undulations; for otherwise it would present no sound record. This, however, is simply impossible.

Still, nobody can deny that in this Carbonel article a process of etching sound records is suggested, and if we purposely disregard the fact that the suggestion is hopelessly absurd, we may say that Mr. Berliner is anticipated by Carbonel.

I do not wish to be understood that Mr. Cros's suggestion of etching can be classified with that of Carbonel: The Carbonel etching process is upon its face an impossible one, while Mr. Cros's suggestion is not, theoretically, absurd; it is merely hopelessly inadequate.

Similarly, there is no absurdity in Messrs. Bell and Tainter's suggestion of making a laterally undulating sound record by the engraving process, if they really ever made such a suggestion; but the suggestion is hopelessly inadequate, and, so far as any accessible public records justify us of speaking about these matters, ~~xxxxxx~~ ~~is~~ a laterally undulating record of sound waves has never been made by anybody, by the

engraving process.

In order to appreciate what Mr. Berliner has accomplished by making a laterally undulating record groove of even depth, by etching, it will be necessary that his record-grooves be compared with the record-grooves obtained by the engraving process of Messrs. Bell and Tainter, which are grooves undulating in depth. This comparison is afforded by an inspection of Defendants Exhibit No. 24, ^{together} ~~and comparison~~ with Defendants Exhibit No. 23. Exhibit No. 24 is a microphotograph of a series of Gramophone grooves taken from a section of a commercial gramophone plate, with the same magnification as was used in making the microphotograph of ^{the} graphophone grooves represented by Exhibit No. 23. A still easier comparison is afforded by Defendants Exhibit No. 26, in which the gramophone grooves and graphophones grooves are represented by diagrams made, as nearly as it was possible, to scale, each enlarged two-hundred times. The greatest care was taken to make this drawing very accurate. Comparing these two ~~two~~ kinds of grooves it will be seen that the graphophone grooves are wide and exceedingly shallow, with their adjacent edges coalescing; while the gramophone grooves are very much narrower and very much deeper, being, by comparison with the graphophone grooves, steep pits of narrow, deep, channels. Moreover, the edges of the gramophone grooves do not coalesce, but have wide, even, ~~plateaus~~ plateaus of varying width between them. These plateaus are in most cases wider than the grooves themselves, and in many cases twice and more than twice as wide

as the grooves themselves .

But while the configuration of the two grooves is strikingly different, there is a still greater difference in the manner in which these grooves operate upon the reproducing style in the process of reproduction of the recorded sounds . When sounds are reproduced from the graphophone record-grooves, the style bears with ^{the face of} its point upon the bottom of the groove, and when it meets with an elevation in the bottom it is lifted upon the crest of it, and when it comes above a depression in the bottom it descends down into the same. In other words the point of the style is acted upon by the elevations and depressions so as to make ^{it} ~~the style~~ perform vibrations at right angles to the face of the tablet. This movement may be compared with that of a person skating upon an unevenly frozen lake, except that the lake passes under the skater instead of the skater over the lake. ~~But~~ Whenever an elevated portion of the ice is met, the skater is lifted upon the crest of the ~~x~~ undulation, and when he meets a depression in the ice, the skater drops down into the ^{hollow} ~~bottom~~ of it. If the record tablet shown in the Bell and Tainter patent were horizontal, this would be exactly the movement of the style during reproduction; the style would vibrate in a perpendicular line. This is well understood and recognized in the art, and there can be, and there is no, difference of opinion about this point. In fact the vibratory movements of the style are generally spoken of as up and down movements, although it is well understood that this is only true when the

tablet is a horizontally arranged plate. If the tablet is a vertically mounted plate, the movement of the style is of course in a horizontal line, but always at right angles to the surface of the tablet. The most proper language to describe this movement is to say that the style vibrates in ^a ~~the~~ path, ^{that is} normal, or at right angles, to the face of the tablet, and is actuated by the bottom of the groove.

All this is different with the gramophone record-groove and style. Here the bottom of the groove has no function in the process of reproduction; the vibratory movements of the style are not produced by the bottom of the groove, since the groove is practically of even depth, and if there should be any ^{accidental} variation of depth, ~~accidentally~~, such variations would have no relation to the recorded sound waves; they would be mere accidents of the etching process. The style in this case is ~~not~~ acted upon by the steep walls of the groove, which groove is not only of practically even depth, but also of practically even width; but it is sinuous laterally, the sinuosities corresponding to and representing sound waves. Consequently, in this case it is not the end face of the style that ~~is~~ is acted upon by the undulations which represent the sound waves, but the sides of the point of the style are acted upon. At one moment one side of the point of the style is pushed laterally ^{in one direction,} parallel to the face of the record tablet, and at the next moment the other side of the style is pushed laterally in the opposite direction, parallel to the face of the record tablet. There is in this case no up and down movement, of the style due to sound undulations, but only

sidewise to and fro movement. I shall have occasion, by and by, to refer again to the difference in the mode of reproduction from the graphophone and from the gramophone record; but I here only desire to state that prior to Mr. Berliner's invention no recorded sound was ever reproduced by ~~the~~ giving to the style laterally vibratory movements. At least I am not aware that such thing has ever been done before, and Mr. Cameron does not seem to be aware of it.

As respects the reproducing device used by Mr. Berliner, I have already stated that in his first experiments he ~~was~~ held the reproducer head, having a diaphragm and style mounted thereon, in one hand, with the point of the style engaging the groove, while with the other hand he rotated the tablet. I have also shown that he used sometimes a simple pointed bamboo stick as a reproducer, and that he also held it in his hand. Later on, in 1888, he mounted ~~a~~ ^{the} reproducer upon an arm which was pivoted at the other end so as to have free movement in all directions. In doing this, Mr. Berliner simply copied his own anatomy; he gave to the arm upon which the reproducer was mounted, the same kind of ~~unrestricted~~ freedom of universal movement as was possessed by his own arm with the hand of which he used ^{to} hold the reproducer, in his earliest ~~earlier~~ experiments. During those earliest experiments, as I have stated before, the reproductions obtained were, while quite intelligible and very loud, by no means as good as Mr. Berliner desired them to be, and he ascribed these imperfections partly to the fact that by holding the reproducer in

hand the style was not ~~guided~~ propelled across the record in a straight line, and particularly not in the line of a diameter of the disk tablet. When the record was made the ~~disk~~ ^{was} moved in such ^a straight diametrical line past the style point, or the style point was propelled in such line over the face of the tablet. Now, Mr. Berliner thought that the same kind of lateral propulsion should be given to the style in the act of reproducing ^{as} ~~time~~ was given to the style or to the tablet in the act of recording; he thought that ^{if} ~~this~~ ^{were} ~~done~~ reproduction would be improved. He therefore devised a means for accomplishing this result, and illustrated and described the same in a patent granted to him #564,586, to which I have already referred, and a copy of which I understand will be made an exhibit in this case, to be marked "Defendants Exhibit, No. 28". The reproducing arrangement is there shown in Fig. 10. The reproducer is mounted upon a little truck 55, travelling over a wire 56, stretched in a straight line diametrically across the tablet. In this manner, when the tablet was rotated, the style with its mounting and truck would be propelled across the tablet by the record grooves themselves, in a straight ^{diametrical} ~~axial~~ line.

Afterwards Mr. Berliner found that it made very little difference whether or not the reproducer was propelled across the tablet in a straight or in a curved path, and he therefore discontinued the use of the arrangement shown in Fig. 10 of this patent, and used a simple straight bar, carrying the reproducer head at one end and universally mounted at the other end, in imitation of his anatomy, and which happens to

be the same construction as is shown in Figures 1 and 2 of the Edison English patent #1644 of 1878, ~~in Figures 1 and 2~~. The construction of the arm was possibly changed, from time to time, to adapt it to supporting a large horn or megaphone, and has now the shape shown in Complainants Exhibit Defendants Machine. The reproducer thus mounted is used by swinging the arm around by hand and to insert the style of the reproducer into one of the grooves of the spiral record. Then the record tablet is rotated, and while the lateral undulations of the groove vibrate the style parallel to the face of the tablet, the style, reproducer head, and arm, are propelled across the face of the tablet; & so that the record groove itself becomes the feed spiral. In other words, all gearing for propelling either the tablet or the style over the face of the tablet is dispensed with, and the machine becomes reduced to the smallest possible number of elements, which can never get out of order.

In one aspect of the case it may be said that Mr. Berliner coalesced the two separate spirals of the Edison machine of Figs. 1 and 2 of the English patent #1644 of 1878, namely, the feed spiral 3, and the record spiral, into one.

I am convinced that nobody has ever done this before.

While Mr. Berliner was still at work on the improvements upon his etching processes, he undertook the task of copying the etched record in other, hard, indestructible materials. He aimed at indefinite multiplications of his original record in cheap and light material; so that these copies may be supplied to the market, cheaply.

It would lead me too far if I here undertook to relate how Mr. Berliner started, progressed ⁱⁿ and finally accomplished the production of multiple copies of his original records; and I understand that I am not called upon to do this. It suffices to say that Mr. Berliner made copies in celluloid, in sealing wax, in shellac, in glass, and ⁱⁿ other substances that could be softened by heat, ^{and} in which, after cooling, became quite hard. Finally he adopted hard, vulcanized rubber, as the material which, not only gave excellent copies, but which is practically indestructible, and from which the recorded sounds may be reproduced ^a a thousand or more times, in succession, without ~~exhausting the record~~ materially affecting the clearness of reproduction. These hard rubber gramophone tablets are sold by the hundred-thousands, and have become a staple article of trade; they are as well known as the Welsbach incandescent burner, and a specimen of such record is here in evidence as "Complainants Exhibit, Defendants Sound Record." I have not examined that exhibit, and I do not think that I had it in my hand, but I saw it lying about, ~~and there~~ ^{but} and there is no ~~mistaking~~ ^{mistaking} ~~anything else than a gramophone tablet~~ ^{is no mistaking} ~~doubt~~ that it is a gramophone tablet; it cannot be mistaken for anything else. The manner of making such a tablet is set forth in Mr. Berliner's patent #548,623, Defendants Exhibit No. 10.

(Adjourned until X Saturday January 13th 1900 at 11 A.M.)

Washington, D.C., January 13th 1900.

Met pursuant to adjournment,

Present- Counsel as before.

Q.11- Please consider now, particularly, the Bell and Tainter patent #341,214, in suit, with respect to ~~the~~ claims 19, 20, 21, 22 and 23; and give your understanding of the meaning and scope of these claims. Also state whether, in your opinion, these claims are broad enough to cover defendants' devices on any construction which would make ^{these claims} ~~them~~ good and valid; and ~~gi~~ state your reasons for any opinion you may express.

A- The claims in question have all reference to the reproducing part of the graphophone; but in order to arrive at the proper meaning and scope of these claims, it is not sufficient to read only that part of the specification which refers to the reproducing element; for in each of these claims the "record" appears as an element, and since the record is made by a process that is independent of the reproducing devices, the method of and means for recording, that is to say, for making the record, have to be carefully considered in order to ascertain what this word "record" means in these claims.

I have hereinbefore pointed out that Messrs. Bell and Tainter do record sound waves by causing the sounds to

vibrate a cutting style at right angles to a moving waxy surface; that thereby they obtained a groove with sloping walls, and with elevations and depressions, which, while they are not totally absent from the walls, are most conspicuous and pronounced in the bottom of the groove, so that the really effective portion of the elevations and depressions are found in the bottom. Since a groove by itself is not a sound record, and only becomes a sound record when it can serve for the reproduction of sounds; and since the grooves cut by the Bell and Tainter method can ~~only~~ reproduce sounds only by reason of the elevations and depressions in the bottom, I have always looked upon these elevations and depressions as the true sound record. Everything else about the groove, cut by the recording style, is an incident of cutting by the action of sound, generally, and of cutting with the particular style used by Bell and Tainter, specifically. Thus, for instance, the shallowness of the groove is an incident, and an unavoidable incident of cutting, generally, on account of the difficulty of the cutting style ^{to} ~~of~~ penetrating deeply into the waxy material. Again, the sloping walls of the groove are an incident, an unavoidable one, of the shape of the cutting style employed. It is conceivable that a groove might be cut the walls of which are perpendicular to the face of the tablet, although it is not likely that anybody would undertake to make such grooves with a style that is vibrated by the action of sound waves.

^{when}
~~If~~ in the Bell and Tainter machine the cutting style

is not vibrated by sound waves, it ~~will~~ still cut a groove, a very shallow groove with sloping walls; but such groove ~~would~~ *is of even depth and* contains no sound record, and no sounds could be reproduced ~~on~~ *from* the same. This shows that a groove, even a groove with sloping walls, and a shallow groove with sloping walls, and a shallow groove with sloping walls cut into waxy material, is not a sound record. But if now the style is vibrated by sound waves, it will make a shallow groove with sloping walls in waxy material, as before; but now there will be elevations and depressions in the bottom of the groove, and these will be the only additions to the groove that had been made when the style was not vibrated by sound waves. I think it follows from this, as an unavoidable conclusion, that the elevations and depressions constitute the sound record.

It would seem that I have dwelt upon this feature with unnecessary insistence, since the thing seems so obvious that no two different opinions can be entertained about it. But Mr. Cameron, ~~in his testimony seemed~~, in one part of his *testimony* ~~seemed~~ *seemed* to agree ~~at~~ *with* what I have just said; while in another part of his testimony he seemed to ~~expand~~ expand his understanding of the meaning of the term "record", or "sound record"; and since these terms occur in the claims which I now have to consider, and since the proper meaning of ~~these terms~~ the claims can only be arrived at through the proper meaning of the terms in question, - I am bound to dwell upon them with some insistence.

Mr The meaning which Messrs. Bell & Tainter intended to give to the terms "record" and "sound record" may be gathered from their specification ~~as~~^{and} from emanations traceable to these gentlemen, or to others representing them. The specification first speaks of the "record" on page 1, lines 76-80 as follows:

"The invention consists, thirdly, in cutting or engraving the record in the form of a groove with sloping walls, the sound waves being represented by elevations and depressions at the bottom of the groove or otherwise."

Disregarding for the moment the last two words, "or otherwise", this passage certainly makes the elevations and depressions at the bottom of the groove the sound record proper; or it might perhaps be said that the sound record is constituted by a groove with sloping walls having elevations and depressions at the bottom of the groove.

This is certainly the kind of sound record made by Messrs. Bell & Tainter, and their machine and their process is incapable of making any other sound record. No matter how their machine is used, it will always make a groove with sloping walls, with elevations and depressions in the bottom. It is simply impossible to make anything else with this machine. What this machine can do is exactly described by the 2nd claim of the patent which reads as follows:

"2. The method of forming a sound record by impressing the sonorous vibrations upon it a style in a direction at right angles to the recording surface, and thereby cutting in a solid body a series of elevations and depressions of varying depth, corresponding in form to the sound waves, substantially as described.

I repeat again, that no other kind of sound record than the one described in the fashion above indicated in the patent can be made by the instrumentalities and by the method described. So far as I am aware, no other sound record has ever been made by Messrs. Bell and Tainter, and the phonographs ~~or~~ graphophones that are found in the market can make no other sound record.

This Bell & Tainter patent has been reviewed by Mr. Arthur S. Browne, ~~One~~ of the experts testifying in behalf of the American Graphophone Company ~~the~~ ~~experts~~ in the Leeds case; and this gentleman speaks of the making of the sound record under the Bell & Tainter patent, and of the nature of that record, in his answer to Q.6, on page 18 of that record, as follows:

"This tablet is rotated and, in connection therewith, is employed an engraving or cutting style, adapted to be vibrated in consonance with the sound waves, there being a relative longitudinal movement between the cutting style and the solid surfaced recording tablet, the conjoint action of the tablet and cutting style being to cut out a sound record in the surface of the recording tablet in the form of a spiral groove having sloping walls and an irregular bottom, the irregularities of the bottom corresponding in depth and shape with the loudness and characteristics of the impressed sounds."

The same gentleman ^{is} ~~was~~ also reported, on page 21, as ~~is saying~~ saying:

"The sloping side walls of the sound groove have an important co-operation with the freely mounted reproducing point, since they automatically guide the point to the bottom of the sound groove, the irregularities of which bottom constitute the active sound reproducing agents."

The italics in ~~the~~ quotation are mine. I believe that from
Mr

Mr. Browne's testimony which he ^{thus} gave in support of the American Graphophone Company, and in support of the ~~patent~~ Bell & Tainter patent here in suit, it clearly appears that the sound record made by the instrumentalities and by the method described in this patent consists of elevations and depressions in the bottom of a groove with sloping walls. This is really not called into question by Mr. Cameron; he does not say, and it would be impossible for ^{him} ~~me~~ to say, that by the method and instrumentalities disclosed in the patent any other sound record could be made. But Mr. Cameron insists that, while Bell & Tainter describe only this one sound record, they had in mind other sound records, and that for this reason their claims, meaning the claims here under consideration, extend to the use of the reproducer in connection with other forms of record, and specifically in connection with ~~records~~ sound records consisting of laterally undulating grooves of even depth. Mr. Cameron relies in support of his opinion upon certain words and phrases in the Bell & Tainter specification, and it will be necessary that these words and phrases be scrutinized, in order that it may appear whether Mr. Cameron is right.

(Adjourned until Monday, January 15th 1900, at 11 A.M.)

Washington, D.C., January 15th 1900.

Met pursuant to adjournment.

Present- Counsel as before.

Mr. Lyons continues his answer to Question 11.

A- The words and phrases in the specification x which are of an expansible character, and which would seem to indicate that the patentees had in mind other kinds of records *in addition to which is* ~~that~~ that clearly disclosed, are dispersed throughout the specification, and have to be gathered from all parts of it. Thus I find on the first page, lines 9-14, the following:

"This invention relates to the formation, in a solid substance, of elevations and depressions, or other inequalities corresponding more or less perfectly to the forms of sound-vibrations, and the reproduction, by means of such inequalities, of the sounds represented by them."

Again, on page 1, lines 76-80, I find the following:

"The invention consists, thirdly, in cutting or engraving the record in the form of a groove with sloping walls, the sound-waves being represented by elevations and depressions at the bottom of the groove or otherwise."

Again, there is a passage extending from line 101 on page 1, to line 3, on page 2, as follows:

"The reproducing-style, mounted as just explained, is specially adapted for use in connection with a record in the form of a groove with sloping walls, and this combination is

specially claimed; but it may also be use-fully employed in connection with other forms of record."

Again, on page 4, lines 26-32, there is the following:

"If one talks into the mouth-piece I, the style will be thrown into vibrations corresponding to the spoken words, and the engraved line will be of varying character, the inequalities or variations from uniformity representing the forms of the sound-waves."

Again, on page 4, lines 33-39, there is the following:

"The reproducer K, (shown in Figs. 7 and 8,) for reproducing from the engraved tablet or from other suitable record the sounds which formed said records, has a reproducing style, 26, formed of a narrow metal strip bent near the end, as shown in Fig. 8, and pointed, as shown in Fig. 7."

In all these quotations the italics are mine, and the words and phrases thus emphasized are the only ones in the patent that would convey the idea that these inventors contemplated, or had in mind, any other kind of sound record than one represented by elevations and depressions in the bottom of the groove with sloping walls. What other kind of record these inventors may have had in mind does not quite clearly appear from the specification; but there is one passage in the specification which tends to throw some light upon this question. It appears that Messrs. Bell & Tainter, when they filed their application, were aware of a United States patent granted to C. C. Reynolds #287,166, which is here in evidence as Defendants Exhibit No. 8. In that patent there is described a mode of cutting a sound record in the edge

of a strip of material by vibrating that strip, by sound waves, against a rotary cutter. The record, therefore, thus produced, is not in the bottom of ~~the~~^a groove, but is represented by a ridge which is formed into elevations and depressions. The existence of such record, or the proposition to make such record, was known to Messrs. Bell & Tainter; for they said say in their specification on page 1, lines 37-45, as follows:

"It has been proposed to cut the record in the edge of a strip of metal or other solid material by vibrating the strip in contact with the cutting edge of a rotary disk-cutter; but this proposal is essentially different from this invention, the new mode being applicable to cutting the record upon all sorts of surfaces, and not upon strips only, and is, besides, believed to be later in time than this invention."

With the knowledge of the state of the minds of Messrs. Bell & Tainter furnished by the above passage, ^{the} ~~these~~ words ^{which I have quoted} and phrases of an expansive character, become intelligible, or at least partly intelligible. The "other forms of record," or the "other suitable record," etc., etc., have at once a meaning, when it is known that Messrs. Bell & Tainter had in mind, in addition to ^{the} record formed by elevations and depressions in the bottom of ~~the~~^a groove, also a record formed by elevations and depressions formed upon a ridge of some solid material. We have seen that Lambrigt also had a sound record formed by elevations and depressions on ^a ~~the~~ ridge of solid material.

This is all the internal evidence, furnished by the patent, as respects the character of the "other forms of re-

cord" or "other suitable record" which these inventors had in mind. There is also some external evidence ^{to} ~~with~~ the same effect.

One of these patentees, Mr. Tainter, obtained a patent #341,287, which was issued on the same day as the Bell & Tainter patent here in suit, namely - on May 4th 1886; and in this patent he specifically describes the production of a sound record upon a ridge; and he claims this in the 7th claim of said patent, as follows:

"7. A sound record in magnetic material having a spiral ridge, the irregularities constituting the record being formed in the top of the ridge, substantially as described."

This certainly shows that Mr. Tainter entertained the idea of a sound record without a groove; that he entertained that idea in a somewhat more definite form than it is put forward in the Bell & Tainter patent by the reference therein to the proposed cutting of a record into the edge of a strip.

But this sound record, formed on a ridge, which Messrs. Bell & Tainter certainly had in mind when they wrote their specification, is still a record formed by elevations and depressions; and while such record would come under the expansive terms "other forms of record", and the like, it does not fairly come under those expansive terms which say that the sound record may be formed by "other inequalities" than by elevations and depressions. What these other inequalities may be, the patent does not state, and the imagination of the

reader of the patent is at liberty to roam and to discover what those other inequalities may be. The imagination of the reader, however, is restrained in two directions. In the first place, he cannot read into this patent a sound record formed by such inequalities as cannot be formed by the sound recording devices set forth in the patent; and in the second place, he cannot read into this patent a sound record of formed by such inequalities as are incapable ~~of~~ co-operating with the reproducer to reproduce the recorded sounds.

The claims which I am called upon to consider, are the following:

"19. The combination, with a reproducing-style, of a mounting therefor, which leaves said style-face to move laterally, and thereby adjust itself automatically to a sound-record, substantially as described.

20. The reproducer loosely mounted on a suitable support, so that the reproducing-style is capable of a lateral movement, and may in consequence thereof adjust itself automatically on the record, substantially as described.

21. The reproducer mounted on a universal joint and held against the record by yielding pressure, substantially as described.

22. The combination, with a grooved tablet or other body having a sound-record formed therein, of a reproducer having a rubbing-style loosely mounted, so that it is free to move laterally, and thus adjust itself to the groove, substantially as described.

23. The combination, with the tablet or other body having the sound record formed therein as an irregular groove with sloping walls, of a reproducer having a style for rubbing over said record and mounted on a universal~~xx~~ joint, substantially as described.

In claim 19 there occurs a compound noun, "style-face", and while this word still makes the claim intelligible, it has

been explained by Mr. Cameron that this was a misprint in the patent, and that he had ascertained from the original record of the patent that the words "style" free" should be substituted for "style-face". The explanation is reasonable, and I shall consider this claim amended in this manner.

While the terms of these claims differ from each other, they have all this in common that they are for a ~~device~~ reproducing device so constructed as to allow the reproducing style to adjust itself automatically to a sound record, and specifically to a sound record ^{formed in} ~~existing~~ of a groove with sloping walls. The automatic adjustment of the style is positively called for in terms in ~~claim 18~~ claims 19, 20 and 22. In claims 21 and 23 the automatic adjustment is not called for in terms; but these claims call for a universal joint for the reproducer, and when we turn to the specification we find that the automatic adjustment of the reproducer style to the bottom of the groove is the only function that is ascribed to the universal joint. I believe I have shown this to be so, in the earlier part of my testimony.

I have also pointed out that in order that the style be capable of adjusting itself automatically to the record, it is not sufficient that it have freedom of movement in one direction only, but that it must have freedom of movement both ~~toward and from the~~ in a direction at right angles to the record surface and in a direction parallel therewith. This is quite clear, since if the style is not free to move at right angles to the record surface, and if by reason of

some irregularities in the machine, the record tablet should recede from the end face of the style, even to the extent of one millionth part of an inch, all reproduction would, for that time, cease absolutely; since there could then be no cooperation between the style and the record. This is a mathematical certainty, and cannot be questioned. On the other hand, if the style had no freedom of lateral movement, and if by reason of some irregularities in the machine the record groove and style were shifted laterally with reference to each other, the style would not be in the middle of the groove, in the bottom thereof, where, according to the specification, it must be. Consequently, the whole universal joint, both the movement of the style in a vertical plane and in a horizontal plane, is necessary for the accomplishment of the results aimed at, namely- for the automatic adjustment of the style.

Now, in claims 19, 20 and 22, only the lateral free movement of the style is positively called for; but since this movement alone will not accomplish the automatic adjustment, it is clear that the capability of vertical movement of the style (movement at right angles to the record tablet) must also be read into these claims. This means that the whole universal joint must be read into them.

I am aware that what I here say is not quite in accord with a certain passage in the specification. The passage is found on page 4, lines 79-84, as follows:

"It will be seen that the reproducer is mounted on a universal joint, so that it can move in any direction. The movement parallel with the face of the

tablet would, however, by itself allow the style to follow and adjust itself to the record to a useful extent."

Here the patentees evidently mean to indicate that it is not absolutely necessary that all the functions of a universal joint be performed in order that the style may adjust itself automatically to the record, and that freedom of lateral movement alone might be useful for this purpose, to a certain extent. Now, while the patentees say that; I am bound to disagree with them, and I disagree with them because unless this style is maintained in contact with the record, it cannot by any possibility reproduce any sound whatever during the time that it is out of contact; and because, unless there is such contact, the style can have no lateral movement, since it must receive that movement from the record; and, finally, because unless this style has freedom of movement toward the record, it will not be maintained in contact with the same.

I really cannot see how there can possibly be any dispute about this. This is not ^a ~~this~~ question that is clouded in uncertainty and with respect to which one person may have more experience than another; but it is a pure question of geometry. It is geometrically certain that if a style be so mounted that it has no freedom to move in a direction toward the tablet, and if there are such irregularities in the machine that will withdraw the ^{bottom of the groove} ~~style tablet~~ from contact with the style, there can be no reproduction. It is also geometrically certain that no amount of freedom of lateral movement

can bring the style to the bottom of the groove. Under such circumstances, it is not I who disagrees with Messrs. Bell & Tainter, but it is geometry that disagrees with ~~him~~^{them}. ~~It~~

The fact, however, is that Messrs. Bell & Tainter did not really mean seriously that freedom of lateral movement alone will be sufficient to allow the style to adjust itself to the record. The passage which I have above quoted is only a half-hearted statement of their proposition; ~~they say~~^{it says} that the style will under such circumstances adjust itself automatically to the record "to a useful extent", and while this is, as I have said, only a half-hearted statement of the proposition, I cannot admit that under such circumstances there can be automatic adjustment to any extent.

With reference to the reproducer used in connection with the apparatus shown in Figs. 18, 19 and 20, the patentees say that with this form of machine it is less important that the point of the reproducing style be visible, open to inspection, and they then add:

"The same may be said of the loose mounting of the reproducer, although in point of fact the thin rubber diaphragm 38 gives a certain lateral play to the style."

(Page 6, lines 11-14.)

Now, a style mounted upon a thin rubber diaphragm, when the diaphragm is so thin as to give to the style free lateral play, sufficient for the purpose; ~~it~~^{such style will} certainly ~~gives~~^{have} also [^] free play toward and from the record tablet. In other words, we have here a complete universal joint, and not only a mounting that will give freedom of lateral movement

alone. What is true of this style mounted upon a thin rubber diaphragm, is also true of every style mounted upon any diaphragm that can be vibrated by a sound record; that is to say, every style mounted upon a diaphragm of any kind is universally mounted. To be sure, the freedom of both lateral and vertical movement, under such conditions, is exceedingly small; but Messrs. Bell & Tainter say that it is enough, and I certainly agree with them. Mr. Cameron in his testimony was asked this question:

"X.Q.193- And is this true; that is to say is it true that if the reproducer had only freedom of moving to any degree parallel to the face of the record, it could adjust itself automatically to a record?

To this question, which went exactly to the point which I am now considering, Mr. Cameron answered:

" A- I think it is, though I should not regard a reproducer which was rigid so far as vertical movement was concerned and free only to move parallel with the face of the tablet, as being an ideal construction. The preferable form would certainly be the loosely mounted reproducer whereby it is enabled to float as it were upon the surface of the record responding as a whole to the grosser irregularities of the tablet and always maintaining the reproducing style in position to be accurately operated upon by undulations of the record groove."

In other parts of his testimony Mr. Cameron enlarges upon this; but from what I have here quoted it will be seen than Messrs. Bell & Tainter that Mr. Cameron is even more half-hearted with respect to the proposition that freedom of lateral movement alone will be sufficient to secure automatic adjustment; he really wants a "loosely mounted reproducer", a reproducer so mounted that

"it is enabled to float as it were upon the surface of the record."...

I fully agree with him in this respect, and I therefore reiterate that all the claims of the patent which I am here considering, require that the style have not only freedom of lateral movement, but also freedom of movement in a direction perpendicular to the record tablet, since otherwise the style could not adjust itself automatically to the record;

There are two ways of giving to the style freedom of universal movement. One is to give to the style itself a universal mounting, and the other is to give to the reproducer as a whole a universal mounting. The universal joint therefor may be such as will leave the reproducer, as a whole, absolutely fixed in position, but will allow one element of it, the style, to move universally; or the universal joint may be such as will allow the reproducer as a whole to move freely in all directions, and ^{will} take the style along with it. Both constructions are shown in the patent. In the machine of Figs. 18, 19 and 20, the reproducer as a whole is fixed; it is adjusted to a definite position as a whole, until the style engages the record, and is then clamped in that position. The style, however, being mounted on a thin rubber diaphragm has universal movement.

In the ~~machines~~ machines shown in the other figures of drawing the whole reproducer head is universally mounted of which on the short section of rubber tubing ~~which~~ I have repeatedly spoken of and in such construction the whole reproducer head will be free

will be free to move in any direction, and will take the style along with it. The distinction between these two constructions is marked in the claims. Claims 19, 22 and 23 require that the style itself have the universal mounting, while claims 20^{and} 21, require that the reproducer as a whole have the universal mounting. This difference is here of interest mainly in one respect, namely- in so far as it ^{shows} ~~sees~~ how much freedom of universal movement is required in order to allow the style to adjust itself automatically to the record, ⁱⁿ of the terms of the specification, -

"so that it is free to follow the sound record or phonogram"; -

or so that

"it is free to follow the record"; -

or so that

"it will gravitate to the bottom of the groove"; -

or, again, so that the style will automatically adjust itself

"to the proper place on the record".

When the universal mounting is applied to the style itself, as in the construction shown in Figs 18, 19 and 20, ~~and~~ the freedom of universal movement is limited by the flexibility of the diaphragm; it is a freedom of universal movement that can rarely exceed one-one-hundredth of an inch, either in a lateral direction, or in a direction at right angles to the face of the tablet.

(Adjourned by consent of parties to meet subject to agreement of parties)

Washington, D.C., March 10, 1900.

Met by agreement.

Present- Counsel as before.

Mr. Lyons continues his answer to Question 11.

A- When the universal mounting is applied to the reproducer head in the shape of a short section of flexible rubber tube ~~xxxxx~~ ^{as} is described with reference to the machines shown in the other figures of drawing in this patent #341,214 the freedom of lateral movement of the style may be slightly greater although this is very doubtful, and as I expect to show further on it is never utilized to any greater extent than about one-hundredth of an inch, and probably not more than to the extent of one-two-hundredth of an inch.

From what I have so far said the meaning and scope of the claims in question become quite clear; and I shall now consider each claim separately.

Claim 19 reads as follows:

"19. The combination, with a reproducing-style, of a mounting therefor, which leaves said style-face to move laterally, and thereby adjust itself automatically to a sound-record, substantially as described."

I shall consider this claim as if the words "style free" were substituted for "style-face", as Mr. Cameron has said ought to be done, and which seems reasonable. This claim covers a combination of structural elements, and according to

my understanding there are three elements to this combination, namely,

- 1st. A reproducing style-
- 2nd. A mounting for the reproducer style of such character as will leave the style free to move laterally, and
- 3rd. A sound record to which the style may adjust ~~it~~ itself automatically by reason of its freedom of lateral movement.

I will here say again what I have said repeatedly before, that since the lateral movement alone will not permit the style to adjust itself automatically to a sound record, the freedom of vertical movement must also be read into the claim; and I wish ^{this} to be so understood, whenever I speak of the freedom of lateral movement, in connection with these claims. Any form of reproducing style will satisfy this claim, and any kind of mounting for the style which will leave the same free to move laterally, sufficiently free to adjust itself automatically to a sound record, will satisfy this claim, and any kind of sound record that is so formed as will permit this style to adjust itself automatically to it, will satisfy this claim, but all these three elements must be present, and must be present so as to co-operate with each other in order that the claim be satisfied. If the construction be such that special care were necessary to insure the adjustment of the style to the record, then it would not contain

the elements called for by this claim; for the specification of the patent says upon this point:

"No special care is necessary to insure its adjustment, for if the reproducer K be allowed to rest against the record with the style upon the engraved line the style will of itself gravitate to the bottom of the groove."

(Page 4, lines 62-67.)

Or if the construction were such as to make it difficult that the reproducing style should touch the record precisely at the proper point, which we have seen is the bottom of the groove; then again such construction would not satisfy claim 19. In other words the construction must be such that nothing is left to be done by the user of the machine than to let the reproducer drop upon the record tablet; the reproducer must then find its proper place automatically; and as we have seen, its proper place is the bottom of the groove where the elevations and depressions representing sound waves are found. The style point must make contact with these elevations and depressions automatically, and must maintain itself in that position automatically.

Claim 20 is as follows:

"20. The reproducer loosely mounted on a suitable support, so that the reproducing style is capable of a lateral movement, and may in consequence thereof adjust itself automatically on the record, substantially as described."

The language of this claim differs considerably from that of claim 19, but the substance of this claim is

the same as that of claim 19, with this difference that whereas claim 19 calls for a mounting for the reproducing style, claim 20 calls for a mounting for the reproducer as a whole. In all other respects the two claims are identical in substance and all that I have said with respect to claim 19 is applicable to claim 20.

Claim 21 is as follows:

"21. The reproducer mounted on a universal joint, and held against the record by yielding pressure, substantially as described."

The language of this claim is widely different from the language of either claim 19 or claim 20; but here again the substance of the claim is the same. The "universal joint" called for by this claim, is really nothing but a mounting for the reproducer that will leave the same free to move both laterally and vertically. A universal joint means a construction whereby the thing thus jointed is free to move in all directions. Now this claim 21 demands that the reproducer be held against the record by yielding pressure, and this pressure we know from the specification is obtained by gravity, somewhat modified by the resiliency of the rubber tubing which supports the reproducer. The claim, therefore, speaks, in terms, of the vertical movement of the reproducer only; but, of course, for this purpose no universal joint is required, since a simple hinge would do the same thing.. It is therefore evident that the construction, in order to satisfy this claim, must be such as to permit the reproducer to move not

only in the direction in which it must move in order to be held against the record by yielding pressure, but also in other directions, and notably in a direction parallel to the face of the record tablet, that is to say, laterally. Only when the reproducer can thus move freely in at least two directions, can it be said that it has a universal joint.

Moreover, I think I have made it clear that the of the universal joint whole object, aimed at by the inventors, was to endow the reproducer style with the faculty of adjusting itself automatically to the record; and I think that I have made it clear that for this purpose ~~xx~~ the style must have freedom of movement laterally as well as vertically.

Claim 22 is as follows:

"22. The combination, with a grooved tablet or other body having a sound-record formed therein, of a reproducer having a rubbing-style loosely mounted, so that it is free to move laterally, and thus adjust itself to the groove, substantially as described."

The language of this claim is again different from that of the preceding claims; but here again the substance of the claim is the same. The same elements which are either recited or necessarily included in claims 19, 20 and 21, also appear in this claim 22. The record is in this claim defined as "a grooved tablet or other body having a sound record formed therein"; but the reader of claims 19, 20 and 21, was led by the specification to read into these claims just such a record, that is to say, one that is formed in a groove which groove in its turn is formed in a tablet or other body. The reproducer style is in this claim 22 called "a rubbing-style"

style", ~~and since~~ that is to say a style that rubs over the elevations and depressions in the bottom of the groove. Now the reader of the preceding claims can have had no other reproducing style in mind, since the specification conveys no idea of any other kind of style. This style must, according to claim 22, be "loosely" mounted, so loosely ^{as to be} ~~that it is~~ free to move laterally, and thus adjust itself to the groove. But all this is also called for by the preceding claims, as I have, I believe, sufficiently shown. We have, therefore, in this claim 22, defined precisely the same combination of elements that we have in claims 19, 20 and 21.

Claim 23 is as follows:

"23. The combination, with the tablet or ~~with~~ other body having the sound record formed therein as an irregular groove with sloping walls, of a reproducer having a style for rubbing over said record and mounted on a universal joint, substantially as described."

This claim, again, in slightly different words calls for the same elements that are called for either in language or by unavoidable implication by the other claims. The record groove, however, in this claim 23 has, necessarily, sloping walls; but since the specification reveals no other record groove, the reader of the preceding claims will read from the same just such and no other record grooves. The style in this claim 23 must be adapted ^{for} ~~for~~ "rubbing over said record", but since no other style is disclosed in the specification, the preceding claims carried to the mind of the reader just such style.

Each of these claims terminates with the phrase "substantially as described", whereby the reader of the claims is referred to the specification for the proper interpretation of the meaning of any phrase or word that might not be quite clear by itself. This interpretation should be rather liberal than strict, for it cannot be expected that an inventor be painfully accurate in the use of his phraseology or terms; it cannot be expected that an inventor, when writing his specification, would choose his terms and phrases with such exceeding care as will leave nothing open to doubt, and it is indeed questionable whether it is at all possible to choose language that will carry to all minds ^{precisely} the same meaning. It has therefore always been a rule that a claim in a patent receives its proper meaning from the specification as a whole, and not merely from one or another phrase that may be found in the same. It is also my experience that sometimes a happy phrase or expression in a claim carries its meaning back to the specification, of which the claim is real-
only
ly ~~an~~ a part.

I have read this patent with this understanding, and with these rules in mind, and I may say that I am in the habit of reading patents in this manner. In fact, the training which I received while Examiner in the United States Patent Office developed this habit with me.

Having read this Bell and Tainter patent in the spirit which I have here indicated, I find that Bell and Tainter disclose in the same one invention which has made its mark in the art of recording and reproducing sounds. They

have cut loose from the traditional mode of recording sounds by substituting the engraving method for the indenting method. They show how to engrave a sound record in a wax-like material and they thus produce a groove, a very shallow groove with extremely gently sloping walls and with elevations and depressions in the bottom of the groove; these elevations and depressions represent the sound waves of which they are the product. From one part of the specification it might seem that they also contemplated of cutting a sound record upon a ridge of waxym material, thus obtaining elevations and depressions on that ridge instead of in the bottom of a groove. From other parts of the specification it would seem that these inventors also contemplated of cutting a sound record into the bottom of the groove without sloping walls, although I do not believe that this can be successfully done. There are only a few rather vague expressions in the specification that would lead the reader to suspect that something of this sort was in the minds of these inventors.

So far as the cutting or engraving of a sound record is concerned, Messrs. Bell and Tainter are probably the pioneers.

inventors

Now these ~~inventors~~ found that with their engraved record which is so extremely shallow (being 20 times wider than deep), and with such extremely shallow record cut into a waxy compound which is rather soft and plastic, it will not do to require the user of their machine to adjust the reproducing style so that it will safely bear upon the bottom of the

bottom

groove without at any time leaving that ~~wax~~, without at any time losing contact with the same even by one-millionth part of an inch. They found that some means would have to be devised for securing such adjustment automatically, and they secured it by giving to the reproducer style more freedom of universal movement than the old reproducers had. ~~They there-~~
~~fore~~ Universally mounted reproducers or universally mounted reproducer styles were not new when Bell and Tainter entered the field, ^{as} ~~xxx~~ I believe I have abundantly shown ; but these old universal joints were not delicate enough to be used with the shallow engraved wax record, and they therefore made it more delicate, so that there was more freedom given to the style to adjust itself to the record. In this part of their invention Bell and Tainter were not pioneers, but merely improvers, and the improvement cannot be disassociated from their pioneer invention, since it was this pioneer invention, the engraved record with the extremely shallow groove that called for the improvement.

The claims which are designed to cover this improvement, claims 19, 20, 21, 22 and 23 do fully cover it. It seems that the draftsman of these claims has reiterated the same improvement in five counts, in varying terms, in order to be sure that the improvement would be safely covered; and I believe that he succeeded well.

This part of the invention of Bell and Tainter, namely, a reproducer mounted universally so delicately as to enable the style when placed upon a record tablet to seek and

find a record groove automatically by sliding down ~~the~~ a sloping wall and then bear with yielding pressure upon the elevations and depressions in the bottom of the groove, and to maintain that position automatically, is fully covered by the claims which I am here considering; but in my estimation these claims cover no more than just this, under any construction which ~~This brings me~~ would make these claims good and valid.

This brings me to the consideration of the bearing which these claims are alleged to have upon defendants' devices. These devices I have already described ^{generally} in detail and [^] have given the history of their development. It is here only necessary, for the purposes of the question, to consider the reproducing devices, and of these the record made by defendants is an essential part. The record is on a disk of hard rubber of similar compound, and is there represented as a spiral groove of even depth but undulating laterally. By reference to defendants Exhibit No. 23, [^] and by reference to Defendants Exhibit No. 26, I have pointed out that the Gramophone grooves are, by comparison with the Graphophone grooves, very narrow and very steep; but in order that the relation of the style used by defendants to the record grooves used by them, be well understood, it is necessary to consider the two together.

The style used by defendants is a steel needle which is sharply pointed, and is of such size at its point that it

does not quite fill that groove. When held x in the groove it touches the bottom thereof but does not make contact with the sides. It must be understood that when I here speak of the style as being sharply pointed I use these words in the sense in which they would be used by any person who would take hold of the needle and examine it with the unaided eye. If thus examined, the needle would certainly be found to be quite pointed. An ordinary sewing needle will present to the superficial observer such a point. But when examined under the microscope, no needle will be found to terminate in a sharp point. It may be said, without exaggeration, that when sufficiently magnified it will be found that there is no needle that is sharply pointed; but that they all show a dull or obtuse point, somewhat rounded at the end. When largely magnified the point is very dull indeed.

-Adjourned until Monday March 12th 1900.-

Washington, D.C., March 12th 1900-

Met pursuant to adjournment-

Present- Parties as before.

Mr. Lyons continues his answer to Question 11.

I have prepared a drawing which I herewith produce, which represents, upon a very much enlarged scale, the reproducing style used by defendant, and shows that style also in

relation to the record groove . This drawing I understand will be made an exhibit in this case and marked "Defendant's Exhibit, No. 29." *(Drawing of Gramophone Groove and Style.)* There are shown four figures on this drawing, Figure 1 shows a wax style before it has been subjected to wear in the process of reproduction, and shows it inserted in a gramophone record groove. It will be noticed that the style touches with its apparently dull point the bottom of the groove, and is not in contact with the walls of the same. In defendant's machine the arrangement is such that the style ~~is not~~ is not in a vertical position when it is in the record groove, but is inclined toward the plane of the tablet; so that in order to obtain from the inspection of Fig. 1, a correct understanding of the relation of the style to the groove it must be imagined that the style leans either forwardly out of the plane of the paper upon which the drawing is made or rearwardly behind the plane of the paper. In thus making the point of the style smaller than the full width of the record groove, Mr. Berliner only did what Mr. Edison had done, and what the manufacturers of the graphophone do, and what Mr. Tainter had said that ~~it~~ ought to be done; ~~namely~~ I have pointed this out in an earlier part of my testimony. In the case of the graphophone, where the grooves are cut or engraved by a style of definite configuration and size, it is comparatively easy to make the reproducing style narrower at its point than the width of the record groove. The manufacturers have in that case to deal with definite dimensions, and they can therefore do just what they desire to do. In the case of

the gramophone record, however, where the width of the groove depends largely upon the etching action of an acid, which is always more or less erratic and uncontrollable, the point of the reproducing style has to be made as small as practicable, as small as is consistent with strength, in order to be sure that it will be narrower than the width of the record groove. This then is the initial form of the reproducing style; but this form changes, from moment to moment, in a peculiar manner, during the process of sound reproduction. The fact is that the hard rubber record in acting upon the style, acts upon the same like a grind-stone; it grinds off not only the face end of the point, but also the sides thereof, and it does that very rapidly, so that within five seconds after reproduction has begun, the style point has an entirely different shape. This shape I have attempted to ~~represent~~ illustrate in Figs. 2, 3 and 4, of Exhibit No. 28. By reference to these figures of drawing it will be seen that the style point is cut off obliquely and that a tongue is formed at that point, which tongue extends diametrically across the point of the style, so that at the base of the tongue there is formed a flat ledge, on each side of the tongue. The style now rests with these ledges on the tablet, with the tongue extending into the record groove.

. ¶ This change of form of the point of the style; this grinding off of the style point, is easily understood when it is considered that hard rubber or similar compound contains extremely fine granules of sulphur or other substance that is inherently harder than steel. Since in the acts of reproduction

duction the style receives alternately the impact of one side wall and the other of the groove, it is naturally ground off on these sides, as well as at its face. This grinding off of the style point takes place with surprising rapidity; it is so rapid indeed that after a few seconds the style is not solely any more supported by the bottom of the groove, but rests also with its ledges upon the ^{face of the} tablet on either side of the groove, as shown in Fig. 2 of Exhibit No. 28. The tongue of the style is now considerably narrower than the width of the groove, so that when the tongue is just in the middle of the groove it touches neither the walls nor the bottom of the groove. But this condition continues to change from moment to moment, since the grinding action continues ~~in~~ uninterruptedly. The two ledges continue to be ground off, whereby the tongue ~~xxxx~~ ~~to~~ becomes longer, so that when it is in the middle of the groove it again touches the bottom thereof, and is ^{again} ground off the next instant at its ~~xxxx~~ end face, so that again it could not touch the bottom proper, and so forth in continuous succession.

The movement of the tongue of the style from one wall of the groove to the other and again back, is the movement by which the recorded sounds are reproduced, these movements being communicated ~~imparted~~ to the diaphragm of the reproducer. It will be seen from this that the bottom of the groove has no function in the reproduction of the recorded sounds, since it gives no ~~movement~~ movement to the style; but the walls of the groove do give movement to the style and they therefore are the agents,

the only active agents for giving to the style ^{its} ~~is~~ vibratory movement.

It follows, from this that the style does not rest upon the record, since the record is there where the style can not rest, namely along the side walls of the groove. These side walls come in contact with the sides of the style point alternately, and in so doing move it from one side of the groove to the other and grind it off on each side, but the bottom of the groove gives no movement to the style, it only grinds it off. If this groove could be scooped out, by some cutting tool, scooped out so deeply that the tongue at the style point could not by any possibility ever reach the bottom of it; if it were scooped out as deeply as I have indicated in dotted lines in Fig. 2; the recorded sound would still be reproduced, not only as well as before, but much better than before, since the grinding off of the end face of the tongue would thereby be avoided and the extraneous disturbing noises resulting from such grinding action would also be avoided. The reproduction would thus be very much clearer.

I have examined a great many ^{records and} reproducing styles used with defendants machine, as a part thereof, under the microscope, and I have examined them ~~both~~ before they were used for reproduction of sound; after they had been used for a few seconds; after they had been used for the reproduction with a whole tablet, and after they had been used for reproduction from 2, 3, 4, 5, 6 and 7, tablets, completely; and I have always

found that the style before it has been used has the shape and the relation to the groove indicated in Fig. 1, and that after it has been used ~~only~~ for a few seconds, it has the shape and relation to the groove indicated in ~~the~~ Figures 2, 3 and 4.

I do not mean to say by this that the tongue is ^{as} ~~equally~~ well developed after a few seconds of use of the style ~~xxx~~ it is after the style has been used for a longer period; or that the ledge is quite as evenly flat after a few seconds of use than it is after the style had been used for reproduction from the whole record tablet. It must also be understood that one style may be a little harder than another, and that one record groove may grind more forcibly than another; but the tongue is never missing, and consequently the ledge is never missing, even after ^{merely} a few seconds of use.

From what I have here said it will appear that ^{since} the style ^{is} ~~is~~ being pushed from one side wall of the groove over to the other side ~~xxx~~ wall, while at the same time the groove passes underneath the style, the tongue ^{should} ~~will~~ leave a track in the groove that meanders from one side of the groove toward the other side; that is to say, that the track which the tongue leaves will not naturally be in the center of the groove. This is really what happens, as I have convinced myself by examining a great number of record tablets after the recorded sounds had been reproduced. What I have thus observed I have attempted to illustrate ~~by Exhibit~~ in a drawing which I here produce and which I understand will be made an exhibit in this case and marked "Defendants Exhibit, No. ³⁰ ~~23~~, Drawing of Gramophone Grooves and Style-Track."

In Figure 1 of this drawing a gramophone record groove, a horizontal face view of the same, is indicated. In Figure 2 precisely the same record groove is illustrated; but within this latter groove there is shown a stratified line as representing the track of the reproducing style in that groove; a track as I have seen it over and over again, a vast number of times. In fact any of the black gramophone tablets which are now so well known may be picked up, put under the microscope, and a track similar to the one which I have indicated in Figure 2 may be observed in the record groove. It will be observed that the track is sometimes very nearly in the center of the groove, but is in most cases and mainly approaching ~~now~~ more nearly one side than the other. This track is formed by the tongue of the style, as is evidenced by the fact that before reproduction the groove shows no track, but looks as indicated in Figure 1. The reason for this irregularity of the track is quite evident. Supposing the record tablet to move in the direction of the arrow which I have indicated; then it is quite clear that when a convex part of the groove meets the style (the tongue), it will jerk the same away from it toward the concave wall of the groove, so that it will now recede from the convex wall and approach the ~~xxxxxx~~ opposite concave wall. This is repeated, over and over again, and in this fashion the tongue will leave a track that meanders apparently quite irregularly, but in reality quite regularly and in accordance with elementary mechanical principles, from one side to the other of the median line of the groove. This

also explains why the style is rapidly ground off at its two sides and is thus formed into a tongue projecting between two ledges. From this again it becomes quite evident that the bottom of the groove has nothing to do with the vibratory movement of the style and that only the walls of the groove cause that movement; that is to say, the walls are the agents of reproduction. S

Since this is a question of some importance in this case I looked about for some experimental means that would demonstrate positively whether or not the bottom of the groove has any function in the act of reproduction. I devised a number of experiments, one of which I may here ~~describe~~ describe with reference to an apparatus which I used, and which I have illustrated in a drawing which I here produce, and which I understand will be made an exhibit in this case and marked "Defendant's Exhibit, No. ^{31, Drawing of Experimental Gramophone Reproducer.} ~~30~~". There are two figures of drawing in ^{this} ~~these~~ Exhibit, each showing upon an enormously large scale the reproducer style used by defendants, mounted upon the reproducer head ^{which is provided} with an attachment thereto devised for the purpose of the experiment. The ~~reproducer head~~

-Adjourned until Tuesday, March 13th at 10 A.M.-

Washington, D.C., March 13th 1900.

Met pursuant to adjournment-

Present- Parties as before. -

Mr. Lyons continues his answer to Question 11.

A- The elements of construction of the device illustrated in Defendants Exhibit No. ³¹~~30~~, I have marked on the drawing by descriptive words, but in order that the exact meaning and relation of these parts be well understood it will be advisable to compare this drawing with the actual device, namely, with defendants reproducer head. In this reproducer head there is a diaphragm, which is not shown in the drawing, and with the center of this diaphragm ^{connected} is the style support which extends radially across the reproducer head, and terminates in a style socket in which the style is inserted and then clamped tightly in position by a clamp screw, the head of which screw is shown in the drawing. To this device the construction of which is quite readily understood when the drawing is compared with the actual apparatus, I have added a little shoe made of brass, which was secured by two screws with the reproducer head, and one of which screws is shown in the drawing. This shoe extends parallel with and beyond the style socket and style, on one side thereof but is broad enough to extend beyond the sides of the style and it has a flat bottom or shoe face adapted to rest on the tablet. This apparatus I used in the following manner:

I inserted the style in its socket, which it enters quite loosely, and I then put the reproducer in position upon the tablet with the style point in a record groove. The style being loose in its socket, would freely slide down in it until it touched the bottom of the groove upon which it rested by gravity. I then clamped the ~~screw~~ style by the clamp screw so that it was now immovable within the socket. This condition of the apparatus is represented in Fig. 1. I then rotated the record disk and obtained a reproduction of the sounds recorded therein. Immediately the free end of the style was ground off and the two sides of the style were also ground off, so that after a few seconds there was formed at the end of the style the usual tongue projecting from between the two ~~ledges~~ ledges to which I have repeatedly referred. But now the ^{face-}end of the style could only be ground off up to a certain point, since the style was now prevented by the shoe from bearing down upon the bottom of the groove. Thus, after a few moments of use the end-face of the style was free of the bottom of the groove, and neither this end-face nor the ledges between which the tongue projected could be ground off any further, the shoe protecting both against continued grinding off. The sides of the tongue, however, continued to be ground off, so that the tongue became thinner and thinner, until it was practically reduced to a sharp, very thin lamina. In this condition of affairs, which is indicated in Fig. 2, and in this condition of the apparatus, it was physically impossible for the style to bear upon the bottom of

the groove within two or three seconds after reproduction had begun. For in this condition of affairs the operation was the same as if the groove had been bottomless, as if it had been a slot passing right through the tablet. But the side walls of the groove continued to act upon the style, upon the sides of the tongue thereof, and vibrated it by ~~k~~ jerking it alternately from one side of the groove to the other. The reproduction was very good.

Considering now defendant's apparatus, the mode of operation of which I have attempted to make clear, it will be seen that the reproducer, while mounted upon an arm which in turn has a universal mounting, is not adapted to adjust itself automatically so as to bring the style to bear with pressure, yielding or otherwise upon the record. The style does bear upon the bottom of the groove by gravity, that is to say, by the weight of the reproducer and ~~xx~~ of the arm upon which it is mounted; but the bottom of the groove not being the record in the gramophone ~~xxx~~ and not operating upon the style to vibrate the same, it cannot be said, in any sense of the word, that the style bears upon the record. We have also seen by reference to Defendants Exhibits, Nos. 24 and 26, that the successive gramophone record grooves are separated from each other by wide horizontal blank spaces; and it is quite clear that if the reproducer is placed upon the tablet, ^{if} ~~and~~ it should happen that the style comes to rest upon any one of the blank horizontal spaces between two adjacent grooves, ~~there is~~

there is nothing in the apparatus that will make the style to seek and find a groove. It will simply remain on the horizontal blank platform and would remain there indefinitely and never get into a groove if the groove were not brought to it. Of course if the groove is brought to the style, then the style will drop into the groove. Now when Defendant's machine is used in the ordinary way for reproduction the arm which supports the reproducer is swung around by the operator until the style is somewhere above a groove, and he then ~~either~~ selects the particular groove with which he means to begin the reproduction and deliberately moves the arm which supports the head until he can insert the style point in the groove; and he then starts the machine, that is to say, he rotates the tablet. In this manner there is certainly no automatic adjustment of the style to the record or of the style to the groove. It is the operator that puts the style into the groove. When it is in that groove, it does not bear upon the record, since the record is on the side walls of the groove upon which the style cannot bear.

Another mode of starting the operation of defendant's machine is to ~~put~~ first ~~rotate~~ start the rotation of the tablet and then take hold of the arm which supports the reproducer and swing it around until the style is somewhere above the tablet. The reproducer head is now ~~allowed to~~ ~~be~~ gently brought down upon the tablet and it will then bring the style either directly into a groove, in which case there certainly is no automatic adjustment taking place; or it will bring the style upon one of the blank spaces between two grooves. If

this latter is the case, then the continued rotation of the tablet will eventually bring a groove directly under the style which will now drop into it. Here again the style did not automatically adjust itself to the groove, but the groove was brought to the style. It is thus seen that under no circumstances can there be an automatic adjustment of the style to a record groove at the beginning of the operation. Now as the operation continues the style with its reproducer head and with the arm that supports the latter are all gradually swung across the tablet, the style always remaining in the groove and the side walls of the latter impelling the style ~~to~~ across the tablet. The groove therefore has in this machine, not only the function of vibrating the style by its sinuosities, but also to feed the style across the tablet from one end of the ~~style~~ ^{style} spiral groove to the other. In no case does the ~~xxxxx~~, ~~xxxx~~ ^{style} ~~is~~ ~~to~~ ~~say~~, ~~the lateral undula-~~ ~~xxxx~~ bear by weight or other yielding pressure ~~upon~~ upon the record, that is to say, upon the lateral undulations of the groove. In fact this is impossible, since, as we have seen, in the beginning of the operation the style point bears upon the bottom of the groove where there is no record, and as the operation continues and the style point is ground off to a tongue, either that tongue bears upon the bottom where there is no record, or it does not bear upon the bottom at all, but is supported off the bottom by the two ledges between which the tongue projects.

According to my understanding, which I have here in-
before given, claims 19 to 23, inclusive, are all designed to

and do cover the combination with a sound record, of a reproducing style and such mounting for the same as will permit the style to automatically adjust itself to the record; and since defendant's machine does not embody such construction; since in that machine there is no automatic adjustment of the style to the record, I cannot see how the claims in question can have any bearing upon this machine.

All this is only true under the assumption that the claims in question are given a construction which will make them good and valid; that is to say a construction under which they would cover a patentable invention. Of course, if to these claims is given a construction that would make them cover matters that are old in the arts, and that were old in the arts when this patent was granted, or when the application for the patent was filed; then these claims might be said to cover defendant's devices; Under such circumstances, however, these claims would cover very much more than defendant's devices; they would cover old and well known constructions and practices, and would not be good and valid under the law. Mr. Cameron testifying in behalf of complainant has given to these claims a variety of constructions, and I cannot say that I could do justice to Mr. Cameron if I attempted to say exactly what construction ^{he} ~~Mr. Cameron~~ has given to these claims. The reason for this is that in different parts of his testimony Mr. Cameron has given different scope to the claims. Under one of the constructions which I can disentangle from Mr. Cameron's testimony, it would seem that he believes that

19,20+21
 the claims in question must be construed to cover broadly a style provided with a universal joint, irrespective of its relation to a sound record.

As I have said before, I am by no means certain that this is really what Mr. Cameron meant; I have attempted quite diligently to arrive at ^{his} ~~Mr. Cameron's~~ meaning; but I must confess that I am somewhat uncertain about it.

Now, I do not believe that to the claims in question such broad scope can be legitimately given, since a style provided with a universal mounting is a thing that was quite old in the art long before Bell and Tainter entered this field of invention. Such structure has been used for many years in all sorts of gage-lathes and engraving machines; and in proof of this I would only refer to ~~Exhibit~~ Defendant's Exhibits Nos. 1 and 2.

Exhibit No. 1 is a copy of United States patent to W. H. Pease #27,827 dated April 10th 1860. It shows an engraving machine, one element of which is a style marked G, mounted upon an arm of complex structure marked ~~xx~~ g h and n, which is capable of being swung horizontally about a vertical shaft ^E and is also capable of being swung vertically upon horizontal pintles e ~~e~~ e'. The movement in these directions is quite loose. This is a universal joint, as is well understood in the art, and we here certainly have a style mounted ~~xxx~~ universally.

In Edison's English patent #1644 of 1878 (Defendants Exhibit No. 11), ⁱⁿ the machine ~~the~~ shown in Figures 1 and 2,

there is certainly a style, indeed a sound reproducing style, secured to an arm that has a universal mounting as I have hereinbefore sufficiently shown.

In Edison's United States patent for his Automatic Telegraph #313,554, dated March 25th 1879, (Defendant's Exhibit No.4) there certainly is a style mounted upon an arm that has a universal joint, as I have sufficiently shown hereinbefore.

All these devices were well known long before the date of the application for the patent of Bell and Tainter here in suit; so that it is impossible to give to their claims 19 to 23, inclusive, or to either of them, such broad scope as Mr. Cameron has intimated.

-Adjourned until Wednesday, March 14th 1900.

Washington, D.C., March 14th 1900, 11 A.M.

Met pursuant to adjournment.

Present- Parties as before.

Mr. Lyons continues his answer to Question 11.

A- With respect to claims 19 and 20, Mr. Cameron is more emphatic than he is with respect to claim 21. He was asked under cross-examination and answered as follows:

"X.Q.246- Then if you saw a sound reproducer that is mounted upon a universal joint whereon it is free to have unlimited movement in any direction; or if you saw a reproducer so mounted as to give it great freedom of lateral

movement you would not ask to see the record in combination therewith in order to determine whether or not it comes within the scope of claims 19 and 20; but you would at once say that the structures do infringe these claims. Do I correctly understand you?

A- You do.

X.Q.247. And upon the principle which you said was a good one that whatever infringes if later, anticipates if earlier, you would say that such structure if earlier than the invention defined in claims 19 and 20 by Messrs. Bell & Tainter anticipates these claims?

A - I would have no hesitation in stating that a sound-reproducer that is mounted on a universal joint whereon it is free to have unlimited movement in any direction would anticipate either claims 19 or 20 provided it was known to the world prior to the date of the invention of that structure by Messrs. Bell and Tainter. Likewise, if I saw a reproducer so mounted as to give it great freedom of lateral movement I would not hesitate to state that if such were known to the world prior to the date of the Bell and Tainter invention, that it would anticipate claims 19 and 20."

The reproducer of the machine shown in Figs.1 and 2, of the Edison English patent #1644 is certainly mounted on a universal joint whereon it is free to have unlimited movement in any direction; it is certainly so mounted as to give it great freedom of lateral movement, since the use of that machine demands such movement all across the record tablet. Consequently, under the construction given to claim 19 and 20 by Mr. Cameron, these claims are fully anticipated by the Edison English patent. There can be no question whatever about this.

As respects claim 21 Mr. Cameron is not ~~as~~ quite so outspoken, as would appear from his answer to X.Q.251. He was

asked and he answered as follows:

X.Q.251- In your answer to X.Q.243 you said:

"The terms of claim 21 demand notm only
'that the reproducer shall be mounted on a uni-
'versal joint, but that it shall be held against
'the record by yielding pressure, and it would
'be impossible to comply with this last condition
'in the absence of a record."

"I understand this to make the record an implied element of the claim; although I do not overlook the fact that you also said in the same answer that claim 21 might also be construed so as to be satisfied if the reproducer were not held against the record, but were capable of being held against the record if such were present. Now, since it seems that we do not exactly agree as to the scope which you have ascribed to claim 21, please define that scope anew, but if possible in a manner that will leave no doubt as to what you mean?"

A- I should construe claim 21 as defining any reproducer which is mounted on a universal joint and acting in conjunction with means capable of holding it against a record by yielding pressure without regard to whether such record were actually present or not; that is, in my opinion, a machine for reproducing sounds which had a universally mounted reproducer which reproducer had means for holding it yielding against a record, the whole being so positioned that if the record were present it could operate as a reproducer in conjunction with such record, such machine, even in the absence of a record, would infringe claim 21.

In other words, Mr. Cameron construes claim 21 to cover a reproducer which is mounted on a universal joint ~~xx~~ in such fashion that if there were a record present the reproducer would be held against the same by yielding pressure; and such device.

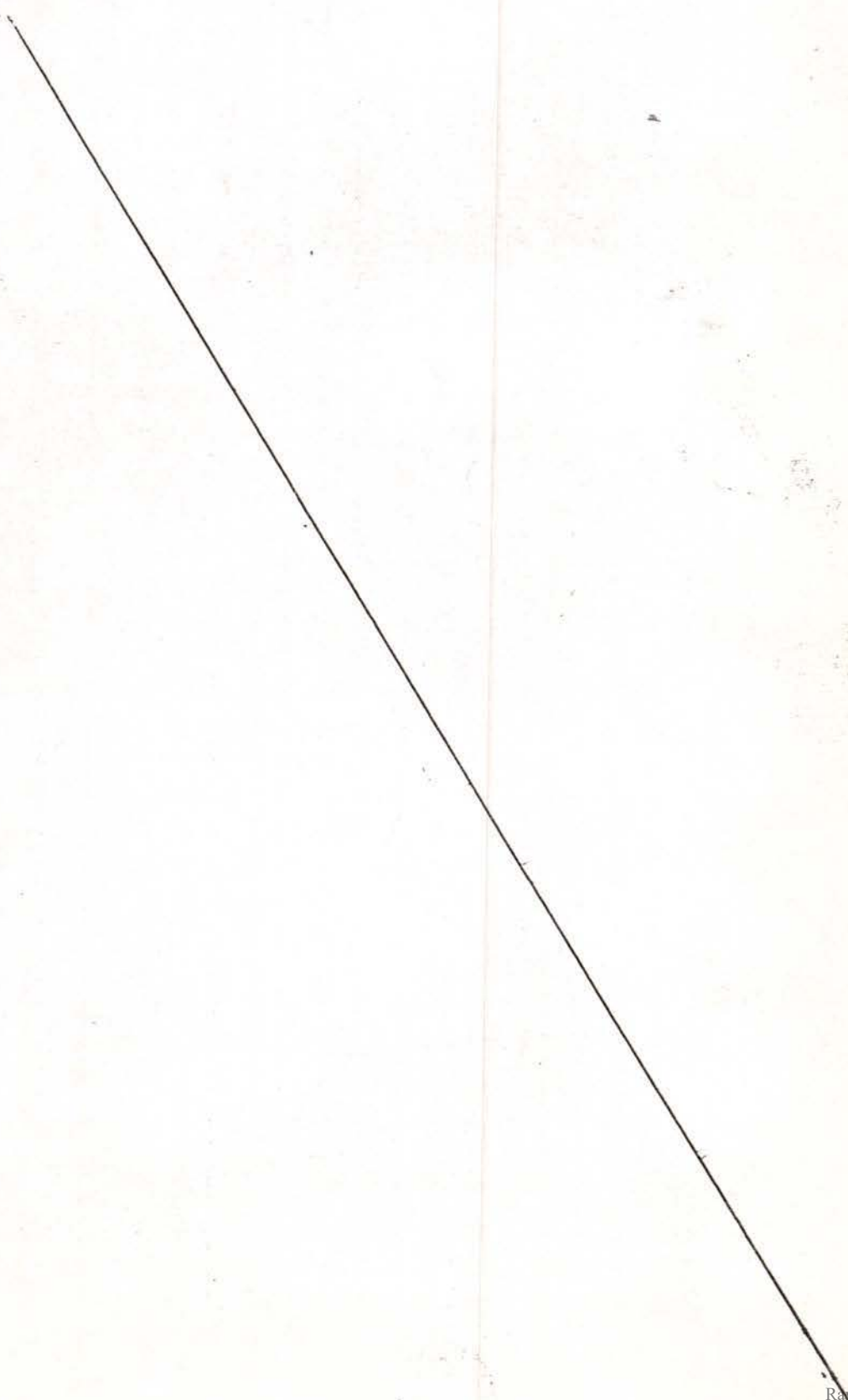
"even in the absence of a record, would infringe claim 21."

A universally jointed reproducer is therefore not sufficient to come under the terms of this claim, according to Mr. Cameron, but the universal joint must be such, or it must be "acting

in

in conjunction with means " ⁵⁰ as to make it possible for the reproducer to bear against the record, if such were present, by yielding pressure.

The means which act in conjunction with the universally jointed reproducer, shown in the patent, is the weight.



of the reproducer partly counteracted by the elasticity of the section of soft rubber tubing. I suppose that a weight, without a counteracting spring would serve the same purpose; or a spring alone without the action of the weight of the reproducer might serve the same purpose. Now if this is really the scope of claim 21, then it is certainly anticipated by Edison's English patent machine as shown in Figs. 1 and 2. There is unquestionably, and beyond the possibility of a doubt, a reproducer held upon an arm which in turn is provided with a universal joint. It is likewise unquestionable that the weight of the arm and of the reproducer will tend to bring the reproducer down upon the record tablet, and I have no doubt whatever that this alone is sufficient to and will bring the reproducer, or rather, the style of the same, down upon the record with yielding pressure. But in addition thereto there is a delicate spring arm e^2 , which extends radially across the diaphragm and which supports the reproducer style; so that as the arm with the reproducer comes down by gravity toward the tablet, it is arrested by the reproducer style coming in contact with the bottom of the record groove, and any further descent of the reproducer must bend the spring e^2 , which can only be done at the expense of yielding pressure exerted by the reproducer style upon the bottom of the record groove. We have therefore in this case, not only a reproducer which is mounted on a universal joint, but this reproducer is also acting in conjunction with means capable of holding it against the record by yielding pressure,

exactly as Mr. Cameron demands . Not only is this so but it happens that in this Edison machine the yielding pressure is also produced by the weight of the reproducer and its arm, partly counteracted by the elasticity of a spring.

It is, therefore, in my estimation, beyond all doubt that if Mr. Cameron's construction of claim 21 were the true one, this claim would be fully anticipated in terms as well as in substance by the Edison English patent machine.

Mr. Cameron either loses sight of the fact that claims 19 and 20 demand that the reproducer must be capable of adjusting itself automatically to a sound record; or at least ~~it~~ does not insist upon such capability. ~~or else~~ Still this is a feature which claims 19 and 20 positively demand in terms, and this is also a feature which must be read into claim 21 in order to make these claims cover something else than what is obviously disclosed in the Edison English patent. I do not mean to say by this that the feature of automatic ^{any} adjustment to ~~the~~ record is new with Messrs. Bell and Tainter. This cannot be justly said since the Edison English patent machine certainly has that feature; but I believe that the Edison machine has not that feature developed with sufficient delicacy for a record formed in the bottom of such an exceedingly delicate and extremely shallow groove as is produced by the Bell & Tainter engraving method.

At any rate, in defendant's machine the reproducer style does not adjust itself automatically to the record, and does not bear upon the record with yielding pressure; and,

therefore, under the construction given to claims 19, 20 and 21 by Mr. Cameron, or under any other construction of these claims that would make them good and valid, they would not be infringed by defendant's machine.

In claim 22 where the sound record is positively made an element of the combination, the automatic adjustment of the style to the record groove is again positively demanded by the claim, in terms; and if this claim is to be good and valid, this automatic adjustment must be sensitive enough, delicate enough, to be effective in connection with such very delicate and extremely shallow record groove as is made by the Bell & Tainter engraving method. An automatic adjustment that is only sufficient for the coarse indented record of Edison will not satisfy this claim, since such automatic adjustment is shown by the Edison English patent machine. Here again this claim is not infringed by defendant's machine, since in the same there is no kind of automatic adjustment to the record.

Claim 23 does not in terms call for the feature of sensitive and delicate automatic adjustment; it does not call for it in terms; but it is my opinion that unless this feature is read into the claim it is absolutely met by the Edison English patent. Every element of this claim is clearly and unmistakeably found in the Edison machine. The claim I will here quote this claim again:

"23. The combination, with the tablet or other body having the sound record formed therein as an irregular groove with sloping walls, of a reproducer having a style for rubbing over said record and mounted on a uni-

universal joint, substantially as described.

Nobody can deny, certainly nobody who can read and understand the Edison English patent #1644, that the machine there illustrated in Figs. 1 and 2, has a combination of the following elements.

1st. A tablet having the sound record formed therein as an irregular groove with sloping walls.

2nd. A reproducer having a style for rubbing over said record and mounted on a universal joint.

I repeat that it is impossible to deny that this is exactly what the Edison English patent machine contains; and nobody can deny that this is quite fully described in that patent. Consequently, if this claim is to be good and valid, something else must be read into it; and it is my opinion that the feature of very sensitive automatic adjustment of the style to the record must be read into it. But if this is read into the claim, then defendant's machine does not infringe it.

-Adjourned until Friday March 16th 1900, at 11 A.M.-

Washington, D.C., March 16th 1900.

Met pursuant to adjournment-

Present- Counsel as before-

Q.12- You have pointed out that in the machine of the Bell & Tainter patent in suit the freedom of lateral movement of the reproducer style is very limited, and is utilized only to the extent of half the width, or possibly the whole width of a record groove. On the other hand, Mr. Cameron in his testimony, with which you are familiar, says in effect that the patent gives to the style a wide range of freedom of lateral movement, and that a much wider range of lateral movement than the width of a record groove is actually utilized in the machines which are in commercial use and which embody the inventions of the patent.

Will you please state whether, in your opinion, Mr. Cameron correctly interprets the patent in suit in this respect, and whether he correctly states the performance of the commercial graphophone; and give your reasons for any opinion you may express?

A- It is my opinion that Mr. Cameron quite incorrectly interpreted the patent in suit and quite incorrectly stated the performance of the commercial graphophone which is supposed to embody the inventions set forth in the patent in suit.

Mr. Cameron bases his judgment as respects the wide the free range of lateral movement of the machine described in the patent upon three pieces of alleged evidence:

1st. Upon the evidence furnished by the language of the patent.

2nd. Upon the evidence furnished by the construction shown in the patent, and

3rd. Upon the evidence furnished by the requirements of sound reproduction.

I do not mean to say that Mr. Cameron thus formally classifies the evidence upon which he relies for, or from which he deduces the wide range of freedom of lateral movement of the style; but when his testimony is carefully examined it will be found that the classes of evidence which I have above enumerated are the ones which shaped his opinion.

As to the evidence furnished by the language of the patent, Mr. Cameron quotes from the specification quite freely, and finds in the quotations which he gives, here and there, a single word, or may be a very short phrase; and from these single words or very short phrases he makes his deductions. Thus, Mr. Cameron quotes from the patent the matter found on page 1, lines 76 to 83, as follows:

"The invention consists, thirdly, in cutting or engraving the record in the form of a groove with sloping walls, the sound-waves being represented by elevations and depressions at the bottom of the groove or otherwise. The advantage of this form of record is that it forms an efficient guide to the reproducing- style."

In his comments upon this passage Mr. Cameron emphasizes that part of it which ascribes to the grooves with sloping walls the particular advantage that it

"forms an efficient guide ^{to} ~~with~~ the reproducing style"

Mr. Cameron next quotes from the specification from page 1, lines 84 et seq.:

"The invention consists, fourthly, in loosely mounting the reproducing-style so that it can readily be guided by the record. Preferably the reproducing-style, or rather what may be called the "head" of the reproducing-instrument, is, mounted on a universal joint, and the style is pressed against the record by the yielding pressure of a spring or weight. Practically in the instruments made by us the pressure is due to the weight of the instrument, modified by the elasticity of a section of soft-rubber tube, which supports the same and constitutes a universal joint; but evidently there are many devices which can be used to mount the reproducer, so that it is free to follow the sound record or phonogram, and which, therefore, would be within the spirit of the invention.. The reproducing-style, mounted as just explained, is specially adapted for use in connection with a record in the form of a groove with sloping walls, and this combination is specially claimed; but it may also be usefully employed in connection with other forms of record....."

Upon this passage Mr. Cameron freely comments and concludes his observations with these words:

"The object of thus loosely mounting the reproducer is not only to enable it to adjust itself to the irregularities of construction, which I have just mentioned, but is also for the purpose of enabling the reproducer to be guided and moved by the record."

The italics are Mr. Cameron's, and I call particular attention to two of the words thus distinguished, namely- to the two

words "and moved," where, in any part of the specification, or in the part quoted by Mr. Cameron, is to be found the idea expressed that the reproducer is to be MOVED, Mr. Cameron does not say. I have myself read this patent over and over again for the purpose of discovering, if possible, something that would indicate that the reproducer is to be "moved" by the record, but I could find no indication whatever. The style of course is to be moved up and down; that is to say, it is to be vibrated by the record, but no other kind of movement, so far as I could discover, is given to either the style or to the reproducer as a whole, by the record. Not even the remotest idea of such a thing can I discover in the patent.

Mr. Cameron then quotes from the specification page 4, lines 68-84, as follows:

"There exists always a liability to disarrangement in some part of the machine either in the recorder or the support therefor or the recording-tablet or its support, or if there be no disarrangement it would be difficult to insure that the reproducing-style should touch the record precisely at the proper point if the reproducer be held rigidly. Difficulties on these accounts are avoided by the loose or flexible mounting of the reproducer, the style automatically adjusting itself to the proper place on the record. It will be seen that the reproducer is mounted on a universal joint, so that it can move in any direction. The movement parallel with the face of the tablet would, however, by itself allow the style to follow and adjust itself to the record to a useful extent."

After having quoted the above, Mr. Cameron remarks:

"As is pointed out in the paragraph of the specification, which I have heretofore quoted, this loosely mounted reproducer is specially effective when used in connection with a record groove having sloping walls, because this form of groove is an efficient guide to carry the reproducing style along over the record."

Here again Mr. Cameron evidently seeks to convey the idea that it is the function of the record groove (because it has sloping walls) to carry the style along, that is to say, to move the style over the record. I myself am unable to find any such idea expressed in any part of the patent, even in the remotest manner. Where Mr. Cameron picked ~~up~~ this idea up, I cannot say; but it is certain that he could not possibly have picked it out of the specification. Several pages further on in his testimony, Mr. Cameron summarizes the advantages of a universally jointed ~~reproducing~~ reproducer, and among these advantages he finds:

- (3) It enables the reproducer to be guided and carried along by the sound-groove, so that the reproducer is free to follow the same and move across the record in a line parallel with the surface thereof."

Here for the first time Mr. Cameron clearly states what he means when he says that the reproducer is moved or carried along by the sound record, or by the sound groove; he means that the sound groove propels the reproducer from one end of the record to the other,

"across the record in a line parallel with the surface thereof."

In other words, Mr. Cameron, somehow or other, discovers in the patent that it is the function of the record groove ~~is the~~ ~~xxxxx~~ to feed the style across the tablet. How he discovered this when not a single word about it is said in the patent; when in fact the whole patent is averse to such idea, Mr. Cameron does not say. The function which ~~here~~ Mr. Cameron ^{here}

ascribes to the record groove, in conjunction with a universally mounted reproducer, is the function which the record groove performs in ~~the~~ defendants machine; but this function is nowhere described, mentioned, or in the remotest manner suggested either by the whole, or by any part of the Bell & Tainter patent in suit; and there is nothing in this patent that would even raise a suspicion that Messrs. Bell & Tainter ever had such an idea; while there is very good evidence in this patent that Messrs. Bell & Tainter never had such an idea

Such evidence is found in the fact that the patent describes and clearly shows a complex system of gearing for propelling the record tablet past the style. I have already described that mechanism, and need not again refer to it in detail. Messrs. Bell and Tainter are inventors of high repute; they are gentlemen of unquestionable and high ability, and it would be preposterous to charge them with the absurdity, with the folly, of inventing and providing a complex piece of mechanism for feeding the record tablet past the reproducer laterally, when they had, as Mr. Cameron means to suggest, already an efficient means for feeding the reproducer across the record, laterally, by the record itself. I should be unwilling to charge Messrs. Bell & Tainter with such stupidity. In the presence of the feed mechanism for the record tablet as shown in the patent and minutely described therein, there is no room for feeding the style across the record tablet either by the record itself, or in any other way.

I cannot, of course, presume to penetrate the mode of

reasoning by which Mr. Cameron arrived at his opinion; but if ^{for} Mr. Cameron reasons, as other people do, then the basis ^{of} his conclusions must be some of the words or some of the phrases of the specification which he quotes in support of his contention; and in fact in the later part of his testimony he does dwell upon a few words or phrases taken from the specification. These words and phrases are those which ~~say~~ say that a groove with sloping walls, having sound waves represented by elevations and depressions in the bottom of the groove,

"forms an efficient guide to the reproducing style," or which say that a universally jointed reproducer

"is free to follow the sound record"; or which say that the movement of the style "parallel with the ^{tablet} face of the ~~xxxxx~~ would by itself allow the style to follow and adjust itself to the record to a useful extent.

Now, as respects the guiding action of the sloping walls of the groove, I have already, and I believe very clearly, pointed out that it means nothing but that a loosely mounted style will ride down these walls so as to come to rest at the bottom of the groove; and that this means, at the maximum, a movement of one-half of the width of a record groove, and that it means nothing else. If I am correct in this then the reproducer or the style is not moved by the record groove, but is allowed to move in the record groove; and that it is moved by gravity, and that the whole movement amounts in each case to not more than about one two-hundredths

of an inch. Similarly when the patent ascribes to the freely mounted reproducer the ability to "follow the record" it means nothing but that with such reproducer the style point will always be in contact with the elevations and depressions which constitute the record in the bottom of the groove.

I find that a highly skilled expert, testifying in behalf of complainants in the Leeds case, Mr. Arthur S. Browne, after quoting the 4th and 9th statement of invention of the patent here in suit, comments upon the same as follows:

"One of the most important results of the freely mounted reproducer is that it is enabled to always maintain register with, or "track" the record groove irrespective of any accidental irregularities in the groove, or lack of symmetry in the recording tablet. Owing to its free mounting or universal connection, the reproducer is not only capable of following the irregularities of the bottom of the sound groove, by virtue of which the sounds are reproduced, but it is also capable of lateral movement to accommodate any accidental lateral deflection in the sound groove, and is also capable of bodily up and down movement to accommodate itself to any lack of symmetry in the recording tablet. Another important result is that the reproducing style or point readily and automatically finds its way into the sound groove at the start without attention on the part of the user, which is a matter of great practical importance since with the microscopical sound groove employed, which is hardly perceptible to the naked eye, it is a matter of great difficulty to adjust a reproducing point so as to register with the groove at its starting point. The sloping side walls of the sound groove have an important co-operation with the freely mounted reproducing point, since they automatically guide the point to the bottom of the sound groove, the irregularities of which bottom constitute the active sound reproducing agents.

(Leeds record, page 21)

It will be seen from this that the expert of the American Graphophone Company perfectly agrees with me as respects the meaning of guiding the style by the record, and

as respects the meaning of following the record; and I really cannot understand how a different meaning can be given to these words and phrases.

- Adjourned until Monday March 19th 1900--

Washington, D.C., Monday March 19th 1900.

Met pursuant to adjournment.

Present- Parties as before.

Mr. Lyons continues his answer to Question 12.

A- According to Mr. Browne the style is guided from the outer edge of a sound-wave ^{groove} down to the bottom thereof, which only requires freedom of lateral movement to the extent of one two-hundredths of an inch; and this is all the guiding there is. Also, according to Mr. Browne the style follows the record by bearing down upon the elevations and depressions in the bottom of the groove; or in his own words:

the
"following irregularities of the bottom of the sound groove, by virtue of which the sounds are reproduced,"

And this is all the following there is. Neither of these two functions imply the propelling of the style across the tablet by the sound record or by the sound groove. In fact such feeding of the style would make the complex system

of gearing by which the tablet is moved laterally past the style, absolutely meaningless, as I have hereinbefore pointed out.

There is perhaps no person more qualified to speak upon this point than Mr. S. Tainter one of the joint inventors of the subject matter of ^{the} patent to Bell and Tainter, #341,214; and he speaks of the freedom of lateral movement that must be given to the style or to the reproducer as a whole, and of the functions of such freedom of movement, in unmistakable terms in his patent #341,288, which is also here in suit. In this latter patent are shown, described and claimed, certain improvements upon the machine and process set forth in the joint patent #341,214. This is evidenced by a paragraph immediately preceding the preamble to the claims on page 9, lines 91-et seq. as follows:

"The present invention is to be considered as an improvement upon or modification of what is shown and described in the application for Letters Patent of C.A. Bell and myself, filed June 27, 1885, and officially numbered 170,044, so far as they relate to common features, and no claim is made herein to any matter described and shown in that application."

The application #170,044, filed June 27, 1885, ~~is~~ here referred to, is the one upon which patent #341,214 was ultimately granted.

I have already spoken of this Tainter patent #341,288, and I have pointed out that in the constructions shown in this patent the style itself has a universal mounting. This mounting of the style itself in a universal fashion is

considered by Mr. Tainter as an improvement over the construction in which the reproducer as a whole has a universal mounting. He explains this quite clearly in his statement of invention in these words:

"Seventeenth. The record is not always perfectly true or straight--that is to say, the recording-style not only moves lengthwise or at right angles to the recording surface, but has or is liable to have a side vibration, which of course is recorded in the tablet. These side vibrations produce errors in reproducing unless means are provided for enabling the reproducing-style to move sideways also. The mounting of the reproducer on a universal joint obviates the difficulty to a certain extent, but not altogether satisfactorily, since the inertia due to the large mass of the reproducer is too great for it to respond as quickly as required. The difficulty is in the present invention overcome much more thoroughly by supporting the reproducing-style so that it, or at least the end in contact with the record, can move sideways independently of the diaphragm or other device upon which it impresses the vibrations. This freedom to move sideways can be secured by allowing the style to rock upon the end in contact with the diaphragm or other device behind, or by making the style in whole or in part of flexible material, or by mounting it on a flexible support, the flexibility of course being in the required direction."
(P.2, line 134-P.3, line 27.)

Mr. Tainter then is of the opinion that a universally mounted reproducer head is not a success and that a universally mounted style is better. Now there may be a difference of opinion about this point, although I should always be inclined to give great weight to Mr. Tainter's opinion. The point, however, upon which I lay stress here is that the freedom of lateral movement given to the style itself and not to the reproducer as a whole is considered by Mr. Tainter to be sufficient for the purpose of reproduction. Now I have pointed out before in connection with this patent that the universal

mounting of the style in any of the several forms shown in this patent, is such that the freedom of lateral movement has only a very narrow range, and I shall now point out from this patent how much of that very narrow range of freedom of lateral movement is utilized.

After describing the preparations which must be made for reproduction, the patent, speaking of the reproducer, says:

.....It is then released, and the reproducer, falling forward, brings the style into contact with the record. Preferably the grooves are so close together that the ridge between them tapers to an edge on top, so that no matter where the reproducer may be placed the style will enter a groove, and being free to move sidewise will, owing to the sloping sides of the groove, penetrate to the bottom thereof under the action of gravity. The fly wheel being turned at about the speed used in recording, the reproducer will follow the spiral groove cut by the recorder, and will be acted upon by the inequalities or irregularities of the record, and made to reproduce sounds or sonorous vibrations similar to those which acted upon the recorder to produce said inequalities or irregularities in the groove."

(P.8, line 83-101.)

We see then that the object of the free lateral or sidewise movement of the style is to move down the sloping sides of the groove, so as to penetrate to the bottom thereof under the action of gravity. The extent of movement laterally, for this purpose is, as I have repeatedly shown, one two-hundredths of an inch.

But Mr. Tainter also demands freedom of lateral movement for another purpose. He says in his patent

".....~~It~~...A slip between the wheels causes the reproducer to be fed faster or slower than the spiral on the tablet

permits the style to advance. As a general thing, there is more slip in recording than in reproducing, and consequently the reproducer outruns the style slightly. The style should be given enough side play to compensate for this difference in speed; but if not given the only difficulty is that the style will at length slip across the ridge between the grooves, and thus escape the action of a portion of the record, so that it may be necessary to bring back the reproducer by reversing the feed."

The freedom of lateral movement is therefore ~~is~~ also ^{slip} designed to compensate for the ~~difference in speed~~, that is to say, for the ~~difference~~ difference in pitch between the feed-screw which advances the reproducer and the groove helix on the tablet. How exceedingly small this difference is in practice, I have already pointed out, but I shall presently have occasion to point this out in connection with actual experiments which I have made for this purpose. At any rate it is certain that the freedom of lateral movement is not designed to serve the purpose of feeding the style across the record tablet by the record groove, since if this were the case there would be no wheels which cause "the reproducer to be fed faster or slower than the spiral on the tablet permits the style to advance." How accurately Mr. Tainter describes the purpose and function of the universally jointed style, we shall presently see.

I think I have now sufficiently shown that Mr. Cameron is incorrect in his interpretation of the Bell & Tainter patent in suit. Certainly his interpretation is not supported ~~is~~, but is, on the contrary, contradicted by the language of the patent; is also contradicted by the testimony of Mr. Browne in the Leeds case, and is also contradicted by

the evidence furnished by the Tainter patent #341,288, which is also here in suit.

As respects the evidence furnished by the constructions of the machines shown in patent #341,214, the same is equally averse to Mr. Cameron's contention. It is here only necessary to consider the machine represented with all its details in Figs. 1 to 11 inclusive, since the machine represented by Figs. 12, 13 and 14, is admittedly inoperative for reproduction, and since in the machine represented by Figs. 18, 19 and 20, the only universal movement which is possible to the style is due to the elasticity of the diaphragm upon which it is mounted, which universal movement is of necessity so exceedingly small that the idea of the style being fed across a tablet is altogether too wild to deserve any consideration.

Now, the universal movement of the first or principal construction shown in the patent is possible only by reason of the mounting of the reproducer upon a very short section of rubber tubing. This rubber tubing must support the reproducer head; it can therefore not be soft and flexible beyond ~~all~~ ^{all} limits. It must have a certain though slight stiffness. Now such a rubber ~~tube~~ ^{tube} will yield to an exceedingly slight pressure to an exceedingly slight extent only. That is to say, it will allow a free movement only to a very slight extent. If it is attempted to give to the reproducer a movement beyond that very limited extent, an appreciable force must be applied. Now, in the machine here under con-

sideration there is no force active that can bend the rubber tube laterally more than perhaps one one-hundredth, or perhaps two one-hundredths of an inch.

This rubber tube has of necessity a certain resiliency; that is to say, it resists quite perceptibly an effort to bend it; it is reluctant of being bent. The patent says this and moreover it is in the nature of rubber that this be so. The patent says, when speaking of the pressure with which the reproducing style bears upon the record:

"Practically in the instruments made by us the pressure is due to the weight of the instrument, modified by the elasticity of a section of soft-rubber tube, which supports the same and constitutes a universal joint;..."

(P.1, lines 92-96)

The action of the weight of the instrument is therefore modified by the elasticity, which means the resiliency of the soft rubber tube. This resiliency therefore must be quite appreciable, since otherwise it could not modify the action of the weight of the reproducer. It follows from this that the free movement in a lateral direction of the style, permitted by the universal joint ~~is~~ shown, must be exceedingly small. But this exceedingly slight freedom of lateral movement is all sufficient for the purposes of the Bell & Tainter machine, since the record tablet is moved positively laterally past the point of the style; the style therefore has only to move laterally for the purpose of adjusting itself from the edge to the bottom of the groove, and may be a little, more, very little more, to compensate for the difference of

pitch between the feed screw and the record spiral. This difference is under all circumstances so very small that it must be measured by thousandths of an inch.

Of course if one undertook to deviate from the description in the patent and from the showing of the drawing in the patent, a machine could be constructed in which the style might be fed ~~at~~ ~~xxx~~ part way across the tablet by the record groove; although why anybody should do this, when neither the patent calls for it, nor the construction of the machine requires it, is not clear. The machine if constructed as shown and described in the patent will operate quite well to reproduce the recorded sounds, with no more freedom of lateral movement of the style than say two-one-hundredths of an inch under any and all circumstances, allowing for all possible contingencies. If, however, the construction ~~as~~ shown in the patent and described, rather minutely, were changed, by taking away the gearing and the feed screw; then, making the reproducer arm, that is to say, the tubes which support the head, much longer, and moving the pivotal supports 20 for these tubes farther away from the record tablet, and then lengthening the section of rubber tubing so that it will no longer support the head, and so that it will no more be sufficiently resilient to modify the action of the weight of the reproducer to an appreciable extent; then it might be possible that the ~~side~~ ^{style} would be fed automatically across a portion of the tablet by the groove itself. But when all this has been done the machine and its mode of operation have been changed so as

violate the patent, and the construction thus obtained would no more represent the patent, but would be something new, something that Messrs. Bell & Tainter, so far as the record shows, never thought of. In view of all this I am decidedly of the opinion that the evidence furnished by the construction of the machines ~~shows~~ of patent No. 341,214, shows conclusively that the patent gives to the style a range of freedom of lateral movement to the extent of one or two-hundredths of an inch and no more, and that Mr. Cameron's contention is not supported by the evidence furnished by the construction of the machines shown in the patent.

--Adjourned to meet by agreement.--

Washington, D.C., April 20th 1900.

Met- pursuant to agreement-

Present- Counsel as before.

Mr. Lyons continues his answer to Q.12.

A- The evidence furnished by the requirements of sound reproduction, with a machine of the kind described in the Bell and Tainter patent in suit, is equally strong against the contention of Mr. Cameron that a wide range of freedom of lateral movement ~~has been~~ ^{was} contemplated by the patentees, and must be read into the patent, and particularly into the claims thereof.

Mr. Cameron admits that for the automatic adjustment of the style to the proper place on the record, namely, to the bottom of the groove, only a lateral movement to the extent of one-half the width of a record groove, $\frac{1}{200}$ of an inch, is required; but he is of the opinion that since the record tablets are exchangeable, it might easily happen with a record tablet that was not made on the machine in the hand of the user, that the pitch of the feed screw of the machine differs from the pitch of the record spiral. Also, so Mr. Cameron says, it might happen that the record spirals are not quite concentric, and that in clamping a new record tablet in position for reproduction it would be found that the style is not exactly opposite a record groove; and that, in order that the style may not lose track of the record groove, it must have

freedom of lateral movement to the extent of the eccentricity of the grooves.

All this is quite correct, but all this only requires a freedom of lateral movement which is a little greater than half the width of a record groove. If the freedom of lateral movement is as much as one-fiftieth of an inch, this would under all circumstances be found more than enough to compensate for any irregularities due to the exchangeability of the record tablets, and to eccentricities of the grooves. The dimensions with which we have here to deal are under all circumstances so small that they are measured and are expressed by the one-hundredth parts of an inch. In all machinery a little looseness of the parts is provided to prevent the binding which would otherwise result between the movable and stationary parts. In fact, whether special provision is made or not, there will always be such looseness, simply because it cannot be avoided. Even in the very finest geodetic measuring instruments such looseness is found, greatly to the detriment of the accuracy of the measurements, and most of the so-called "unavoidable errors" of measurements are due to the unavoidable looseness of the parts. The looseness required for a sound reproducer of the kind described in the Bell & Tainter patent in suit, must be a little greater than the "unavoidable looseness" inherent in all machinery, and this slightly greater looseness is provided by the rubber tube universal joint. But this does not mean that the reproducer must have freedom of lateral movement sufficient to propel the same across the record, by the groove.

No useful purpose would be subserved if such universal joint were provided, and the conditions of sound reproduction, with a machine of the kind described in the patent, ~~does~~ not call for such universal movement.

Mr. Cameron, however, finds another reason why the Bell & Tainter reproducer should have a freedom of sweep across the engraved portion of the tablet. He says that while it is true that the tablet is moved in a straight line, laterally under the style point, by a screw and gearing; yet this mode of displacing the tablet laterally is unsafe, and may fail, either momentarily or permanently, and in that case it is necessary that the style have freedom of lateral movement sufficient to be propelled laterally across the entire engraved portion of the tablet.

To my mind this reasoning is based upon nothing that can be discovered in the patent, in which I cannot find even the remotest suggestion of propelling the style across the record tablet by the record groove itself. Why the feed screw provided by Bell & Tainter should, under any circumstances, fail to propel the tablet, passes my understanding. This feed screw and its connected gearing is designed for the propulsion of the tablet, and why in the world it should not always do so, I am unable to understand. Of course there may be a little looseness, and there always would be a little looseness, between the feed screw and its nut; but such looseness would under all circumstances be so exceedingly small that it could never amount to more than possibly the $\frac{1}{500}$ part

of an inch. If it were more than that, the machine would be thrown away, or would be repaired. Mr. Cameron says that if the feed screw failed to propel the tablet, reproduction of sound could not be obtained unless the style were free to be propelled across the tablet by the groove. This is perfectly true, and it is the recognition of this fact, and the further recognition of the fact that the gramophone record groove is capable of propelling the style across the tablet, which enabled Mr. Berliner to make his gramophone reproducer, in which there is no feed screw and no gearing.

In the Bell & Tainter machine, however, there is a feed screw and gearing, and, consequently, successful sound reproduction with such machine requires no feeding of the style by the record groove, even if such feeding were possible, which it is not.

Mr. Cameron says that he used a commercial graphophone embodying the Bell & Tainter invention, for reproduction, and that in the use of that machine he disengaged the feed screw from its nut, so that the style was not any more propelled across the tablet, by the feed screw; and that he found that under such circumstances the style was still propelled across the tablet to the extent of "three grooves."

This would make the freedom of lateral movement of which the commercial machine is capable, $\frac{3}{100}$ of an inch; and this freedom of movement was utilized under conditions which by no possibility could occur in the actual, normal, legitimate use of the Bell & Tainter invention. This freedom of lateral movement was utilized by discarding the mechanism provided by

Bell & Tainter, and by smuggling into the machine, in a half-hearted fashion, the Berliner idea of propelling the reproducer head by the record groove. And even under these unnatural and forced conditions, the maximum extent of freedom of lateral movement that was secured, amounted to no more than $\frac{3}{100}$ of an inch, in one direction.

I have repeated the experiment to which Mr. Cameron referred in his testimony, a great number of times, using the commercial graphophone, of which Mr. Cameron says that it embodies the Bell & Tainter invention. I did exactly what Mr. Cameron said that he did, namely, I disengaged the feed-screw from the nut by which the reproducer head is normally propelled across the record; so that it could not be thus fed across any more, while the record cylinder still continued to be rotated. The result was that I obtained, by way of reproduction, an endless repetition of the sounds recorded upon one and sometimes upon one and one-half turn of the helical record. It was a succession of like sounds or shouts; that is to say, the same shouts were reproduced in succession.

The behavior of the machine was as follows: The style was, owing to the universal joint of the reproducer head propelled across the record tablet to the extent of one or one and one-half the width of a record groove. When it arrived at this extreme excursion, it immediately ~~snapped~~ snapped back to its original position; it was then again fed forward to the extent of one or one and one-half turn of the

helical record groove, and again snapped back to its original position; and so forth, in endless repetition. This means that the style had freedom of lateral movement to the extent of $\frac{3}{200}$ of an inch. Mr. Cameron says that he obtained double this amount of freedom of lateral movement, namely $\frac{3}{100}$ of an inch. I could never obtain as much as this.

I here again repeat that in thus disengaging the feed screw from the nut, the machine was used in a manner in which it would never be used in practice, and in which the patent in suit does not contemplate that it be used. In using the machine in this fashion it was not any more the Bell and Tainter machine, but was really a mutilated Berliner machine, used for reproduction from a Bell and Tainter record tablet.

But when this machine was used in ^{the} ordinary fashion, in the fashion contemplated by Bell and Tainter, and described in the patent in suit, then the freedom of lateral movement utilized, could never have been, by any possibility, more than the $\frac{1}{100}$ of an inch.

This proves to me, beyond any doubt, that the requirements of sound reproduction with the Bell & Tainter machine, do not call for a freedom of lateral movement of the style for more than $\frac{1}{100}$ of an inch, and that the feeding of the style across the record tablet, by the record groove itself, is not only not required, but is positively excluded by the requirements of good sound reproduction, in such machine.

I have already shown that in the Tainter patent #341, 288, which is also here in suit, the style itself instead of

the reproducer as a whole, has a universal mounting, and that in that case the feeding of the style across the record, ~~table~~ by reason of the universal mounting is absolutely impossible beyond the limit of perhaps the width of one or two record grooves. Still the machine of that patent is an improvement upon the machine of the Bell & Tainter patent, and was, *I believe*, ~~in fact~~ the first machine put upon the market by the owners of the Bell & Tainter patent, and it operated perfectly to reproduce recorded sounds. This, I believe proves absolutely that the requirements of good sound reproduction do not call for freedom of lateral movement of either the style alone or of the reproducer head as a whole, beyond the limit of one or two turns of the record groove.

Q.13- You have made an elaborate examination of claims 19 to 23 of patent #341,214, in suit, and have given, at great length, your reasons for your opinion that these claims, if construed to cover patentable subject matter, are not infringed by defendants' devices.

If you can give expression to some of the more salient considerations which shaped your opinion, in a brief and yet comprehensive manner, without extensive or specific reference to the patent, or to the prior state of the art, - please do so ?

A- I shall attempt to do what I am now asked to do, although I am conscious of the fact that I may not succeed as well as I wish.

Bell & Tainter were the first to suggest the engraving method of recording sounds in wax-like material, and they made this method a success. Under this method they produced a very shallow record groove with walls so gently sloping that it is difficult, without a very careful examination of the groove, even if the same is artificially and very largely magnified, to see and appreciate the slope. The most efficient part of this record, and the only commercially efficient part thereof, was at the bottom or center of the groove. The groove was, perhaps, one-hundredth of an inch wide.

For reproduction from such a record groove, the style had to be adjusted not merely to the extent of this one-hundredth part of an inch, so as to be in the groove, but within a space of less than one-thousandth part of an inch in order that its working point be substantially at the center of the groove.

The ordinary mechanical means such as screws and gearing could not safely solve this problem. Bell & Tainter used gearing and a screw, etc., to adjust the style for the one-hundredth of an inch; that is to say, they contrived that by means of a screw and gearing their reproducer style was fed along to the extent of one-hundredth of an inch for each revolution. This part of their mechanism I have hereinbefore called their "screw-feed". But this was not sufficient to adjust the style to within a thousandth part of an inch.

To accomplish this final and absolutely necessary adjustment they employed a yieldingly pressed and universally

~~jointed~~

jointed reproducer; and such reproducer performed two functions. First- it enabled the style to slide down the very gently sloping walls so as to get to the precise center of the groove in the bottom thereof; the style had to be there and had to remain there at all times in order to obtain good reproduction. This involved something in the nature of a discovery, for nobody could have predicted ap priori that the style would actually slide down such a very gently sloping wall; it required experiment to determine this question. As a matter of fact this sliding down of the style to the center of the record groove is not always safely performed even with the universally jointed reproducer; but it is brought about partly by the aid of the universal joint, and partly by the movement of the record tablet, and must sometimes be promoted by artificially shaking or rattling the machine. In this manner the style is ~~is~~ skewed from the top to the bottom of the groove, not at right angles to the tablet, but obliquely thereto.

Second- The yieldingly pressed, universally mounted reproducer kept the style point in constant and uniform pressure contact with the vertical undulations at the bottom of the groove. This was an absolute necessity, for ~~the~~ with a vertically undulating record it is not permissible that the style point ~~lose~~ lose touch with the face of the undulations by a distance no matter how small, infinitesimally small, if you like; for if such touch is lost there can be no reproduction.

Manifestly then there is a combination between the engraved wax record and the universally jointed and yielding-
 there is an
 ly pressed reproducer; and ~~the~~ invention in this combination by reason of the two functions which I have just specified.

The Berliner sound record being primarily the result of an etching process, need not be and in fact is not very shallow, and certainly its side walls are not gently sloping. The experiments to which I have testified prove that the side walls of this record groove do the work of reproduction by laterally vibrating the style, and that there is no necessity for any pressure, uniform or otherwise between the style and the record undulations, and that such uniform pressure does not exist. Furthermore, I have shown that it is not necessary that the point of the style be in contact with the bottom of the groove during reproduction. Mr. Cameron has shown this same thing.

It therefore seems to me that it is a matter which admits of no doubt, that the combination of a universally jointed reproducer, with a Berliner record does not perform the two functions which are performed by the combination of a universally jointed reproducer with an engraved wax record; namely, of riding down the very gently sloping walls of a record groove, and of keeping in constant touch, under uniform pressure with the undulations at the bottom of the groove. Yet these two functions are those which made the Bell & Tainter combination patentable. -

If then the Bell and Tainter claims, 19 to 23, are

construed in view of Bell & Tainter's real invention, to cover the performance of the new functions, to cover the ideas, the realization of which is the Bell and Tainter invention; then it is clear that defendant does not infringe these claims. But the question arises on what construction of these claims do the defendant's devices infringe them? The answer is this:

In addition to co-operating with the very gentle undulations or irregularities which constitute the sound record, I mean the operative part which does the work of ^{re}producing sound, the universally jointed reproducer of Bell and Tainter is also guided by or tracked in this groove, just as a boy who has a stick in his hand and runs along the pavement may track the point of the stick in a crevice of the pavement, or just as the arm of a trolley pole is tracked by the trolley wire. Now I must not here make any point of the fact that Bell and Tainter track their style in a groove with very gently sloping walls. Perhaps it required a discovery to determine that this was possible. On this feature I express no opinion for the simple reason that the defendant uses no such groove. For the purpose of this answer I must assume that Bell & Tainter track a style in a groove of ^{any} desired cross-section. By so doing their universally mounted reproducer is enabled to rise and fall, if the tablet is warped, in order to compensate, not for the minute irregularities which constitute the sound waves, but for the grosser irregularities which are introduced by the reason of the warping of the

tablet or by other faulty constructions of the machine as a whole or of the record tablet. So too the universally mounted reproducer of Bell & Tainter permits of a free lateral adjustment, not to co-operate with any peculiarity of the undulations of their sound record, with which we are not here concerned, since the Berliner record does not infringe that, but to compensate for the grosser lateral irregularities of the machine and of the record tablet, which may be the result of faulty construction or of lack of proper centering of the record tablet.

If now Bell & Tainter can be given a patent for a universally mounted style which has no limitation in construction or mode of operation in connection with the sound irregularities, but which is for the mere purpose of adjusting for the gross irregularities which inhere in sound reproducing machines, the same as in all other machines, then, under such construction of the patent, the defendant's device would infringe the same. I am satisfied that I have shown, and ^{matter of} that it is a mere mathematics to show, that there can be no infringement under any construction of the patent that is less broad.

I may here be permitted to note that the decision of Judge Grosscup in the *Amet* case substantially held that the universally mounted reproducer, if not used in connection with the engraved wax record, performed no other than the ordinary function of every universal joint. I also find that Judge Shipman's opinion in the *Leeds* case, although he seemed

inclined to go beyond Judge Grosscup, considered the combination of the universally mounted reproducer patentable, because and in virtue of the function it performs in co-operating with the peculiar vertically undulating engraved record of Bell and Tainter.

Q.14- You have, in the foregoing answer, assumed it as a fact that a universally jointed arm, used for the mere purpose of tracking a groove or a wire ~~is~~ not patentable, or was not patentable at the date of the Bell & Tainter application. Will you now make ~~kgood~~ this assumption, if you have not yet done so in your preceding testimony?

A- An arm mounted in a universal fashion for the purpose of tracking generally, is such a common device and is so well known in the arts, and was so well known for such a long time prior to the date of the application for the Bell and Tainter patent in suit, that I might well have abstained from mentioning this fact or from pointing it out specifically in my preceding testimony. There are certain things that are so well known that it may safely be assumed that everybody knows ^{them} ~~Q.~~ The universally jointed arm used for the purpose of tracking generally, is one of those things. However, I believe I have referred to some specific instances in my previous testimony, but I shall now, under the lead of your question, do so again and perhaps amplify it a little.

In Defendant's Exhibit No.16, which is a translation from the well known Treatise of Physics and Meteorologie by

Dr. Joh. Muller, there is described and illustrated a rheostat which is a device for varying the electrical resistance of an electric circuit. This rheostat consists of a cylinder of non-conducting material, which has cut upon its surface a fine helical groove. In this groove is wound a fine ^{metallic} ~~platinum~~ wire which slightly projects beyond the surface of the cylinder. The cylinder is mounted upon a shaft which can be rotated in its bearings by a crank. Parallel with the cylinder is arranged a rod which is held at each end by a spring ^{and these two springs} ~~which~~ ^{which} tend to throw the rod toward the cylinder. Upon this ^{a loose,} rod is ~~splined~~ a little metal roller, which is provided with a fine circumferential groove, so that as the rod, upon which the roller is ^{mounted,} ~~splined~~ is thrown by the springs toward the cylinder, the fine groove on the roller engages the ~~platinum~~ wire wound in the grooves of the cylinder and makes good electrical contact with the same. It will be seen that this roller is thus universally mounted, since it bears with yielding pressure upon the wire on the cylinder and is free to move laterally being loosely ~~splined~~ mounted upon the rod so that it can both rotate on the same and freely slide along on the same.

When the cylinder is rotated the roller bears with constant although yielding pressure (the pressure of the springs which carry the rod) upon the metal wire, and at the same time ^{the roller} travels along the rod, either to the right or to the left, according to the direction of rotation, and tracks the wire from one end to the other of the helix.

In an apparatus of this kind it is of the utmost importance that the contact pressure between the roller and the wire be constant, since the least variation of the contact pressure would produce a variation of electrical resistance which would make the whole apparatus useless. We have, therefore, in this apparatus not only a device which is universally mounted for the purpose of tracking, but which also bears with yielding pressure upon its track, in such manner that the contact pressure is as nearly constant as anything can possibly be made. The wire is described as having a diameter of from one-half to one millimeter, which corresponds to one-fiftieth to one-twenty-fifth of an inch.

Muller's book was published in 1858 in Braunschweig, Germany, and is a celebrated treatise of Physics and Meteorologie, and the rheostat there described is found in many electrical laboratories, all over the world. This rheostat, in its original construction, had not the contact roller mounted upon a universal joint, but only on a single joint, and instead of the spring, ~~xxxxxxx~~ the pressure of a weight was used for obtaining the constant contact pressure between the roller and the wire. This construction is shown and described in Poggendorff's Annalen der Physik und Chemie, Vol. 59, published in Leipzig, Germany in 1843. A translation of that article is here in evidence as Defendant's Exhibit, No. 17.

Universally jointed arms carrying styles for tracking grooves, are very common in engraving machines, or as they are sometimes called "Rose Engines". As specimens of such

machines I have already hereinbefore referred to the patent to W.H.Pease, #27,827, dated April 10th 1860 (Defendants Exhibit No.1), and to the patent to H.W.Hayden #38,823, dated June 9th 1863 (Defendants Exhibit No.2). In the English patent to Edison #1644, dated April 24th 1878, in Figs.1 and 2 thereof there is shown, as I have already pointed out a universally jointed arm carrying a sound reproducer for tracking the sound groove.

In Edison United States patent #213,554, dated March 25th 1879 (Automatic Telegraph), there is also shown a universally jointed arm carrying a style for tracking the groove; the groove in this instance is a telegraphic record groove, and a copy of the patent is in evidence as Defendants Exhibit No.4.

In Count Du Moncel's book, Defendants Exhibit No.21, there is shown a species of Edison's Phonograph with a universally jointed arm carrying a sound reproducer, the style of which tracks a sound record groove.

I have already referred to Edison's patent No.227, 679, May 18, 1880, (Defendant's Exhibit No.6) and have shown that it describes with reference to Figs.3 and 4 a phonograph in which there is an arm carrying a sound reproducer and that this arm is in a manner universally jointed and that the style of the reproducer tracks a record groove.

In all these cases constant pressure is exerted upon the track whether the same be a groove or a wire. The arrangement of ^a ~~the~~ universally jointed arm used for the purpose

of tracking, is such a common thing in various arts that I thought that I was justified in assuming it as old and well known, without specially pointing out instances where this construction is found, in the course of my preceding testimony; but the instances to which I have now referred will be sufficient to show that my assumption ^{was} ~~is~~ justified.

- Adjourned until April 21st 1900, at 11 A.M.)

Washington, D.C., April 21, 1900.

Met pursuant to adjournment.

Present- Counsel as before.

Q.15- In an affidavit filed on the part of defendants in this case on the motion for a preliminary injunction, which affidavit was executed by Henry C. Brownell on November 29th 1898, I find among others the following extracts from complainants brief filed in the case of the American Graphophone Company vs. Leeds:

"The Self-Adjusting Reproducer,-- The merit of this feature of the invention lies not only or mainly in the fact that it does away with all necessity for adjustment, either laterally or radially, of the record cylinder, and that it insures contact with uniform pressure between the reproducing stylus and the undulating line of the record. Its chief merit lies in the part it played in the development of the engraving method."

.....

"It is material also to consider the character of the sound record for the purpose of determining the question of infringement of claims 22, 23 and 24. If defendants employed a record that was not an engraved record, a different issue would arise, namely, whether those claims

could be so broadly construed as to cover such different record."

.....

"This cut or engraved sound record, having these characteristics, was the sound record which Judge Grosscup assumed to be new. Defendant's expert and counsel now find themselves obliged to make the same assumption.

"We have, then, in claims 22, 23 and 24, a combination involving two elements, one of them a specific sound record, the product of a specific method of recording, and which is new beyond all question; the other element being a reproducing device of particular construction, which, even if old per se, was certainly new in the specified combination."

.....

"If defendants employed a different sound record from the commercial engraved sound record made under this patent, a question as to the breadth of claim would arise, and it would be for the Court to decide whether claims 22, 23 and 24 are broad enough to include such different construction. But when the defendants' machine is furnished to be used with the very sound records made by complainant and its licensees, the Court will, we think, confine itself to the actual things before it. This is what complainant's expert has done (see, for example, X. Q. 49 et seq., p. 36), declining to express opinions as to the operativeness, in this combination, of hypothetical records existing only in the imagination of defendants' counsel.

"In claim 22 the sound record is defined as "a grooved tablet or other body having a sound record formed therein:" claim 23 defines it as 'the tablet or other body having the sound record formed therein as an irregular groove with sloping walls;' claim 23 defines it as "a sound record formed in wax or wax-like material."

"Although none of these claims specify an engraved record, the specification describes no other, the industrial art knows no other with which the defendants' machine could be used, and it is admittedly made for that use. From these facts it follows that the claims, which refer to the specification, certainly cover that sort of record, whether or not (should a case ever arise presenting that question) they cover a different sort of record."

Please state whether I have quoted the above extracts correctly.

A- I find that the extracts are correctly quoted in

the question.

Q.16. Mr.Cameron, the expert who testified in behalf of complainant, gave it as his opinion that in defendant's Gramophone, the reproducing style snugly fits the record groove; that it consequently presses simultaneously against both walls of the groove, and that, therefore, the style bears with yielding pressure upon the lateral irregularities which represent the record.

You, on the other hand, have in your preceding testimony shown that in defendant's devices the reproducer style does not normally bear upon the two walls of the record groove. Will you now consider the procedure adapted by Mr.Cameron for ascertaining the relation of the style to the record groove, and state whether, in your estimation, that procedure was calculated to throw light upon this subject?

A- That part of the testimony of Mr.Cameron, to which you have referred comprises his answers⁹ to Q.8 and his answers to X.Qs.311 to 324, inclusive. Speaking of defendants sound record and style, Mr.Cameron ~~said~~ in his answer to Q.9, said:

"I find that the grooves are exceedingly fine and thread-like and quite shallow, and that notwithstanding the fact that the reproducer point seems sharp to the touch, that it is, when compared with the thread-like groove of the record, quite blunt. When the point of the style rests in the groove it travels along the bottom thereof fully filling the groove and contacts at all times with the walls of the groove on both sides, that is, the style does not move back and forth across the groove, but fits snugly therein so that the sloping walls of the groove act simultaneously on the opposite sides of the style point and guide the same."

In his testimony, under cross examination, Mr. Cameron states, pretty clearly, the method which he employed for ascertaining the relation between the style and the record groove. He shows that he took a cross section of a gramophone plate; that he mounted the same horizontally, whereby the cross-sectional plane became vertical; that he mounted a gramophone reproducer head in the usual fashion and allowed its style to drop into a record groove, and rest in the same by gravity, and that he then examined the groove and style together from all imaginable positions, by microscopes, with a magnifying power between 14 and 30 diameters.

In this procedure the style was sometimes brought forward toward the cross-sectional plane as far as possible, without slipping off, and sometimes it was placed in the groove some distance behind the cross sectional plane. With this position of the object to be examined the microscope was moved around it, sometimes directed toward the cross sectional plane and sometimes toward the surface of the tablet; and the microscope was, as I have stated, of a magnifying power of from 14 to 30 diameters.

I am prepared to say, without hesitation, that under such circumstances an observer can see almost anything he desires to see; but he will particularly see, with ease and comfort that the style fits the groove snugly, since the two images of the groove and of the style point, will, under such circumstances, never be in the same focus, and one of them will expand to meet the other and coalesce with the same, even if

the style were quite considerably narrower than the groove.
I am also prepared to say that an expert microscopist, if he had undertaken to observe the relation of style and groove in the fashion adopted by Mr. Cameron, would not undertake to say with any degree of security what he had seen. An expert microscopist would at once know that under such conditions of observation everything is deceptive, and that particularly the coalescence of the two objects is deceptive.

The gramophone record grooves are about $\frac{1}{250}$ of an inch in width, and a style which may be quite loose in such groove, so as to be entirely out of contact with the walls thereof, may leave on either side, between itself and the walls, a space of not more than $\frac{1}{2000}$ of an inch. To look into such a ~~space~~ space by a microscope of any kind, no matter what its magnifying power may be, under the conditions which Mr. Cameron provided, is absolutely futile; it is impossible under these conditions to see such a space, which is limited on one side by a black hard rubber wall, and on the other side by the reflecting surface of a style. It is of no consequence to consider how Mr. Cameron may have illuminated his objects; the diffraction of light coming from ~~the objects as~~ ~~together~~ a slit as narrow as $\frac{1}{2000}$ of an inch would bring about the phenomenon of light interference, so well known to microscopists, which would result in total darkness at and about the space between the style in either wall of the groove. But the impossibility of focusing both the side of the style and the edge of the groove at the same time is

all sufficient to coalesce the two images, even if there were no diffraction and consequent interference of light.

It is a fact, however, that persons who are not accustomed to the use of the microscope and especially of such of higher magnifying powers, will imagine to see all sorts of things which in the nature of things they cannot possibly see. And this I believe to have been the case with Mr. Cameron in the experiments which he made. His mode of attacking the problem of ascertaining the relation between reproducer style and record groove was a hopeless one, and far from being calculated to throw light upon the subject, it was bound to throw the subject into shade; and for this reason he ~~was~~ believed that he saw the style snugly fitting the record groove.

Q.17- Please consider now whether the Bell & Tainter Graphophone devices, as shown and described in the Bell & Tainter patent in suit, could be used for the purposes of the Gramophone, and vice versa; and state your reasons for any opinion you may express?

A- If the engraved wax ~~xxxx~~ record of Bell & Tainter were attempted to be used with defendant's reproducer, it would result in the immediate destruction of the record without obtaining any reproduction of the recorded sounds. The style of defendant's reproducer would dig into the wax tablet and would scoop out the bottom of the record groove and disfigure it beyond all recognition. I have done this myself, and I saw at once that it would be the height of folly to

attempt to obtain reproduction of sound by a gramophone reproducer from a graphophone tablet. When I prepared for making the experiment I knew beforehand that reproduction could not possibly be obtained in this fashion; I ~~am~~ also expected to find that the style would injure the record, but I did not expect to find that it would so absolutely destroy it as it actually did. The graphophone record tablet which I used was a modern one, which is very much harder than the record tablet described in the Bell & Tainter patent in suit; still ^{gramophone} the ~~graphophone~~ style took hold of it like a chisel and simply scooped the groove out, making it useless for all future purposes.

Supposing, however, that the graphophone record had been cut into a tablet of hard indestructible material like hard rubber, or, say, like steel; still there could have been no sound reproduction ~~either~~ in accordance with the principles of the gramophone or in accordance with the principles of the graphophone. Both instruments require that the diaphragm be vibrated transversely to its plane, and only if so vibrated would it work in accordance with the intent of the inventors. Now when a gramophone reproducer is agitated by a graphophone record, the diaphragm receives shocks or impulses in directions parallel with its plane. This may, and probably would give some sound, but it would be a most miserable affair under all circumstances and would be repudiated both by the American Graphophone Company as well as by the National Gramo-

phone Company, and neither party would call it sound reproduction. It is simply a fact that no matter how ~~you~~ a sonorous body is agitated it will emit sound in a fashion. Thus a speaking tube is designed for the transmission of the air vibrations which accompany the utterance of sound, and for this purpose there is a clear air passage provided from the mouth of the speaker to the ear of the listener. But if a speaking tube happens to be stuffed up so that there is no more any clear air passage, the speaker, if he speaks ~~loud~~ enough will be heard in a manner. In that case it is the material of the speaking tube itself which is vibrated by the voice and which transmits sometimes sufficient sound to make communication possible. In something like this fashion a graphophone tablet of steel would work upon a gramophone reproducer. But since the graphophone records are not cut in steel or hard rubber, but are cut in a wax-like material, no reproduction at all, but simply a destruction of the whole record is obtained.

When it is attempted to reproduce sound from ~~an~~ a gramophone hard rubber/record-tablet by means of a graphophone reproducer, the latter must be mounted to be free to swing laterally across the tablet, in accordance with Mr. Berliner's invention, since the gramophone has no feed screw and gearing for propelling either the tablet or the reproducer head laterally. But when this is done, then indeed a kind of reproduction is obtained; and it is of the same kind as would be obtained if a gramophone reproducer were used with a grapho

phone record cut into hard rubber or steel; or of the same kind as is actually obtained by a speaking tube that is completely stuffed up. I have made this experiment and the result was just what I have described. There was a kind of reproduction, but it was a ludicrous kind of reproduction, such as would be repudiated both by the American Graphophone Company and by the National Gramophone Company; and would ~~not~~ still more surely be repudiated and ridiculed by the public.

Altogether I have found that the graphophone and the gramophone reproducing devices cannot be used interchangeably; and this irrespective of the facts that the graphophone tablet is at once destroyed when used with the gramophone reproducer. The reason for this is quite clear when it is considered that in the graphophone/^{of}Bell & Tainter the style must vibrate at right angles to the record surface in response to the irregularities in the bottom of the record grooves; while in the gramophone the style must vibrate parallel with the face of the record tablet in response to the sinuosities of the walls of the record grooves. The two modes of operation positively exclude each other.

Q.18- Please examine claim 25 of patent 341,214 dated May 4th 1886 to Bell & Tainter, which is one of the three patents in suit. You may ~~again~~ state briefly whether or not, and if so, why, you consider this claim to be anticipated? You will then proceed to state whether in your opinion this claim is infringed by the defendants devices.

A- The claim in question is as follows:

"25. A reproducer having a style projecting beyond the edge or end of the instrument, so that the position of the point of the style on the record may readily be seen, substantially as described."

The construction defined by this claim is illustrated in Figs. 7, 8, 9 and 10 of the Bell and Tainter patent in suit, and I have already referred to this construction in the course of my answer to Q. 6. There is a statement of invention in the patent which first introduces this feature of the construction defined in claim 25, which statement of invention reads as follows:

"The invention consists, sixthly, in a reproducer or reproducing-instrument in which the reproducing-style, instead of being placed behind its support, projects at the point beyond the edge thereof. One practical advantage of this is that it enables the position of the style on the record or phonogram readily to be observed."

(Page 2, lines 14 to 21).

~~Later~~ Later on in the patent after the reproducer had been described there is the following statement:

"It will be observed that in both forms of reproducer the style 26 projects beyond the edge or end of the instrument, so that the position of its point on the record can be easily seen."

(Page 4, lines 124-127.)

No other utility is ascribed to this construction than that the point of the style can be easily seen, or can be readily observed. I could never understand, and I cannot now understand, why the inventors of the graphophone should have had any desire to observe the point of the style. The patent

does not state why this is desirable and what use it could serve to look at the point of the style. The closest observation of ~~this point~~ the point of the style while it tracks the groove, or while it rests in the groove, can be of no possible use to anybody. In the graphophone which is found in the market, the point of the style does not project beyond the reproducer head and cannot be seen during reproduction and no person ever found fault with the commercial graphophone on this account. In other words, in my estimation no useful purpose is subserved by exposing the point of the style to view; nobody ever experienced any inconvenience from the fact that in the commercial graphophone the point of the style cannot be seen. No graphophone, so far as I am aware, ever came upon the market with the point of the style projecting beyond the ~~the~~ edge of the reproducer head.

In defendants device the style does project beyond the edge of the reproducer head, and it is visible; But it is not visible during reproduction because it projects beyond the edge of the reproducer head, but because the reproducer head is used edgewise, and not flatwise as in the graphophone, And the reproducer head is used by defendants edge-wise because the nature of their record compels them to do so, and not because they want to look at the point of the style, since no amount of looking at it would teach either them or the user anything; it would be an absolutely useless gazing. To my mind claim 25 of the Bell & Tainter patent is quite frivolous.

In defendants device the point of the style, although projecting beyond the edge of the reproducer head, could easily be made invisible when in position on the record, by a shield that would hide it from view; it would thereby lose all that utility which Messrs. Bell & Tainter ascribe to the projecting style; but it would thereby not lose any of its utility as a sound reproducer; it would be protected against the vulgar gaze of the world, but this is all the harm that would be done to it.

It is very difficult to speak in a serious vein about this claim 25, which to my mind is nothing but the result of a whim, and the fact that the use of this construction has been abandoned by complainants, proves to me the absolute uselessness of it, and I have no hesitation in saying that no trace of invention can be found in it.

The claim, moreover, is fully anticipated in the United States patent to A.W. Hall, #219,939, dated September 23rd 1879, (Defendant's Exhibit No. 5) to which I have already referred in my answer to Q. 6. I have there pointed out that in Hall's machine there is an arm secured to the center of the diaphragm of his reproducer, which arm projects far beyond the reproducer head, and which carries two reproducing styles at its free end, which, for this purpose, is forked. The terms and the substance of claim 25 of the Bell & Tainter patent are fully met in the Hall patent, and this claim, therefore, even if it defined an invention, which it does not, is invalid. Reproducer styles in sound reproducing instruments, projecting

from the reproducer head in a fashion to be clearly visible are also shown in other patents; as for instance, in Edison's English patent #2909 ~~affs~~ of 1877 in Fig.8 thereof, and in ~~Englis~~ Edison's English patent #1644 of 1878, in Figs.17,18 and 27.

-Adjourned until Monday April 23, 1900, at 11 A.M.-

Washington, D.C., April 23rd 1900.

Met pursuant to adjournment.

Present- Counsel as before.

Q.19- Please examine claim 44 of patent #341, 288, granted to S.Tainter, dated May 4, 1886, which is here in suit. You may state briefly whether or not, you consider this claim to be anticipated, and whether, in your opinion, this claim is infringed by the defendants devices; also give your reasons for any opinion you may express?

A- Claim 44 of patent #341, 288, in suit, is as follows:

"44. The combination, with the reproducer-style and the diaphragm or device upon which the reproduced sonorous vibrations are to be impressed by said style, of a flat metal spring interposed between the style and diaphragm and forming a yielding connection, through which the reproduced vibrations are transmitted, said spring having a practically rigid connection with the diaphragm, substantially as described.

I have already consider^{ed} this claim exhaustively in my answer to Q.8, and I have there shown that the same is fully anticipated by the United States patent to Edison #200, 521, dated February 19th 1878, (Defendants Exhibit No.3) and by an illustrated article in the Scientific Periodical "Nature" for July 4th 1878 (Defendant's Exhibit No.20). I have nothing to add to what I have there said as respects anticipation of this claim.

As respects the question whether defendants devices infringe this claim, it is clear to me that the structure used by defendant is entirely different from any structure shown in the patent of Tainter, and that by no possible construction of the meaning and scope of claim 24 can the same be read upon defendants devices.

Claim 24 requires that there be a flat metal spring interposed between the style and the diaphragm of the reproducer, and that this flat metal spring shall form a yielding connection between the style and the diaphragm. It further requires that the vibrations of the style shall be transmitted to the diaphragm through the spring; and it further requires that the spring shall have a practically rigid connection with the diaphragm.

All these requirements are complied with in the described construction ~~shown~~ in the Edison patent #200, 521, and in the construction shown in the article in Nature; but none of these requirements are fulfilled by defendants reproducer.

In defendants reproducer there is a solid rod extending radially across the diaphragm and projecting beyond the edge of the reproducer head. This rod is ^{cemented} ~~secured~~ by bees wax to the center of the diaphragm, and has formed at its free end a socket for the insertion of the reproducing style, which is clamped in the socket by a little thumb-screw. This socket has a lateral extension which is screwed to the ~~side~~ rim of the reproducer head, and one portion of this lateral extension, a very short portion of it is reduced in thickness so that it might be looked upon as a spring, although it is a very short and stiff spring. This short and stiff spring portion of the lateral extension from the rod serves the function of a pivot. The style carrier therefore is pivoted. But this spring is not interposed between the style and diaphragm, since it is at right angles to both ^{and is far removed from the diaphragm;} it forms no yielding connection through which the vibrations of the style are transmitted to the diaphragm, since the vibrations of the style are transmitted to the diaphragm by the style carrier or rod directly; and this spring has no rigid connection with the diaphragm, since it is not connected with the same in any way or manner. This spring is in one piece with the style carrier and might therefore be said to be rigidly connected with the same (but not with the diaphragm), and is at its other end screwed to the rim of the reproducer head, and not to the diaphragm.

None of the requirements of claim 44 are thus found

in defendants device. It is my opinion that the most superficial comparison of the Tainter device with defendants reproducer should convince every intelligent person that the two have nothing in common, except that they both have a style a diaphragm, and a spring; none of the functions assigned to the spring by claim 44 are performed by defendants spring; nor is defendants spring located and connected as called for by claim 44.

A simple consideration of a most elementary character carries with it demonstrative proof that the defendants device does not infringe this claim. The consideration is this:

Since, according to claim 44, the vibrations of the style must ~~transmit~~ be transmitted to the diaphragm by the spring, it is clear that if the spring were removed, the vibrations of the style could not be transmitted to the diaphragm. This is really the case with the Tainter construction. But in defendants device no person of ordinary intelligence will maintain that if the spring were removed the vibrations of the style would not be transmitted to the diaphragm.

Q.20- Please examine claim 20 of patent #375,579, granted to C.S.Tainter on December 27, 1887, which is here in suit. You may state briefly whether or not you consider this claim to be anticipated, and whether, in your opinion this claim is infringed by the defendants devices. Also state your reasons ^{opinion} ~~opinion~~ for any ~~reasons~~ you may express.

A- Claim 20 of the Tainter patent #375,579, is as follows:

"20. The combination, with the diaphragm of the reproducer, of the rubbing-style consisting of a lever having the rubbing-point formed on one arm and the other connected with said diaphragm, substantially as described."

I have considered this claim quite exhaustively in my answer to Q.8, and I have there shown that the same is fully anticipated by the patent to Edison #227,679, dated May 18, 1880 (Defendants Exhibit No.6). I have nothing to add to what I have there said as respects anticipation of the claim. This anticipation seems to me to be so full and beyond every doubt, and also so clearly exhibited in the Edison patent that a simple glance at the drawings of said patent should be sufficient to convince everybody.

As respects the question whether defendants device shows such construction as is defined in claim 20, the answer must depend upon whether claim 20 should be construed liberally or strictly. The claim, in terms, requires that the style and lever be formed in one piece. The construction shown in the Tainter patent here under consideration discloses the lever and style made in one piece; so that it would seem that the claim was intended to cover exactly what the patent shows. This would seem to be reasonable in view of the fact that if the more liberal construction were given to the claim, by which it would cover the lever with a style secured to it instead of being formed ~~xxxx~~ ~~xx~~ in one piece with it, nobody could doubt, even for one moment, that the claim is met by the Edison patent. It is just possible and in fact it ~~must be xxxxxxx~~

must be assumed that Mr. Tainter was aware of the existence of this Edison patent and that he purposely restricted his claim to avoid this patent. If then the claim be construed strictly, covering the lever with the style formed thereon in one piece with it, then surely defendants device does not infringe, since in defendants reproducer the style is removably secured to the lever; but if the more liberal construction be given to the claim, then defendants device would infringe it; but then the claim would be hopelessly anticipated by the Edison patent.

I may here add that under the liberal construction of this claim it is also fully anticipated by the patent to A.W. Hall #219,939 (Defendants Exhibit No. 5). I have already referred to this patent as showing the style so mounted as to project far beyond the edge of the reproducer head; but an inspection of the patent also shows that the style is at the free end of a two-armed lever, the other arm of which is connected with the diaphragm.

Counsel for defendant now offers in evidence the following Exhibits:

Defendants Exhibit No. 25, Graphophone Cutting Style and Scale-Photograph.

Defendants Exhibit No. 26, Drawing of Graphophone and Gramophone Grooves.

Defendants Exhibit No. 27, Graphophone Reproducer-Style and

Scale-Photograph.

Defendants Exhibit No.28,Berliner Patent #564,586.

Defendants Exhibit No.29,Drawing of Gramophone Groove and Style.

Defendants Exhibit No.30, Drawing of Gramophone Grooves and Style-Track.

Defendants Exhibit No.31,Drawing of Experimental Gramophone Reproducer.

Defendants Exhibit No.32,Edison English Patent #2909 of 1877.

Direct examination of Mr.Joseph Lyons is here closed.

Adjourned to meet by agreement between counsel.

Ad. 33 Synthesis

" 34 Exam + S.

Washington, D.C., July 25th 1900.

Met pursuant to agreement of counsel.

Present- Philip Mauro, Esq., for Complainants.

Horace Pettit, Esq., for Defendants.

Cross-examination of Mr. Joseph Lyons, by Philip Mauro Esq.

X.Q.21- You have referred in your deposition to certain ~~patents~~ taken out by Mr. Berliner for improvements in the art of recording and reproducing sound, are you the same Joseph Lyons who acted as solicitor in securing those patents?

A- Yes, I am the same Joseph Lyons.

X.Q.22- Who is the owner of those patents at this time?

A- I have not the remotest knowledge, as respects this point. I here mean to say that I have no positive knowledge ~~xxxxxx~~ about the ownership of these patents. I have, of course, in the course of years heard of transactions with respect to these patents, but I paid so little attention to it, that I could not give any information as to who now owns these patents.

X.Q.23- Do you know of the existence of a Company called the United States Gramophone Company, and of another Company called the Berliner ~~xxxxxx~~ Gramophone Company?

A- Yes, I know of the existence of these Companies

and I was at one time an officer of the United States Gramophone Company. I was an officer of that Company by courtesy.

X.Q.24- These Companies are conducting the defense of the present suit and are the real defendants herein, are they not?

Objected to as not proper cross examination and further as incompetent, irrelevant and immaterial.

A- Yes, I understand these Companies are defending this suit.

X.Q.25- You are a member of the firm of Lyons & Bissing, are you not?

A- Yes.

X.Q.26- And that firm is retained and acting as counsel for the defendants herein, I believe.

A- Yes.

X.Q.27- You are the same Joseph Lyons who appeared as counsel for defendants and conducted the cross examination of complainants expert, Mr. Cameron?

A- Yes.

X.Q.28- I infer from a previous answer that you are no longer an officer of the United States Gramophone Company. Are you still a stockholder of that Company?

A- Yes, I am a stockholder of this Company. It will be proper in this connection for me to state to what extent I am interested in the United States Gramophone Company.

I own 25 shares, I think, of common stock, of this Company, and I receive, whenever dividends are declared semi-annually between six and seven dollars as my share of the profits of the Company. When the question arose how to obtain the services of an expert in behalf of defendants in this case it was found that such experts as the Company had in view on a former occasion when it contemplated bringing suit against infringers, were not any more available. Those experts and ~~these~~ also legal advisers had in the meantime lost all desire to serve this Company. They were Messrs. Mauro and Cameron. They were not any more available, and it was necessary to look out for somebody else. Now, it transpired that nobody that had any practical knowledge, more than academic knowledge of this art, could be secured, since they were all more or less connected with the American Graphophone Company, and under such circumstances it was decided that I should be the expert.

I proposed at that time that I should first purge myself of all interest in the financial fortunes of the company, but this proposition was received by a shout of laughter, seeing that ^{the} stock which I owned and the dividends which I received were so ridiculously small.

X.Q.29- Your, client, Mr. Berliner, is largely interested in the United States Gramophone Company, is he not?

A- Yes, I think he is the President of the Company. But even of this I am not quite sure.

X.Q.30- And you have been for many years his personal counsel in patent matters?

A- Yes, I have so testified.

X Counsel for Complainant objects to the deposition of this witness so far as it purports to give expert evidence on the ground that the witness is manifestly disqualified as an expert herein; and counsel for complainant submits that the views and the arguments of defendants counsel should be presented to the court in brief and not in the record under the guise of testimony. Counsel for Complainant therefore moves that the deposition so far as it purports to be the deposition of a scientific expert, be excluded and costs thereof ~~xxxx~~ taxed against defendants.

X.Q.31- In your answer to Q.10, you give an historical account of the experiments of Mr. Berliner which came under your observation beginning in the spring 1887, and after describing his attempts to produce a record on glass by indirect etching, you state on typewritten page 112, that early in 1888, Mr. Berliner entirely abandoned indirect etching on glass and attempted direct etching on a zinc plate. On that and following pages you mentioned difficulties encountered in this scheme, referring to long and tedious trials and long series of experiments having for their object the removal of these difficulties, and on page 116 state that Mr. Berliner at last conceived the idea of protecting the wax film during the process of tracing the record by covering it with alcohol.

Please state when ~~this~~ when or about this was?

A- I cannot definitely, but I believe that this occurred either in the fall of 1888 or in the spring of 1889. The fact itself is very clearly present to my mind, but as respects the date, I cannot give definite information.

X.Q.32- Further along, you state that the presence of the alcohol was found objectionable in the etching bath and on page 119 state that Mr. Berliner conceived the idea of removing the alcohol by washing it off. Can you tell when this ~~was~~?

A- I can give no date, but I believe that this occurred perhaps two or three months after the alcohol was first used.

X.Q.33- This is the last step mentioned by you in Mr. Berliner's work, and as you state that it removed every trouble and every difficulty that he had had to contend with and that you have attempted to give every step in the development of Mr. Berliner's process of recording sounds, I infer that the washing of the alcohol away with water was the crowning act of Mr. Berliner's work so far as the same came under your observation?

A- There was no such thing as a crowning act in Mr. Berliner's work, so far as it came under my observation. He improved from the beginning of his work and continued to improve, ~~and~~ ~~and~~ ever since. I believe he improves even now and it would only be a form of speech to speak of a crowning act. It is true that not until he removed the alcohol from the etched zinc plate could he with absolute security turn out

one etched plate after the other; but he obtained very good plates long before he thus removed the alcohol and he also obtained quite good plates even before he employed the alcohol.

It was only a question of continuous successful work. Before he used the alcohol he would sometimes get excellent plates, sufficiently good to put upon the market. Again, at other times, he would get a bad record, and he was led to the employment of alcohol and subsequently to the washing off of the alcohol, not with the view of getting good records, for these he already had, but with the view of getting good records at all times and under all ~~xxxxxxxxxxxx~~ circumstances.

X.Q. 34- Do you wish to be understood from your last answer that the reproduction of etched sound records was successfully accomplished ~~xx~~ prior to the use of alcohol?

A- I certainly wish to be so understood, and from my direct testimony it will appear that I always so understood it. The etching process proper was in no way or manner changed by the employment of alcohol. Mr. Berliner very frequently obtained very good, in fact excellent records, before he employed alcohol; but again, at other times, the records were very bad, and if he had attempted to practice his invention commercially at that time he would simply have been obliged to discard those spoiled records, This would have meant a greater cost in the production of good records, since the cost of the production of the bad ones would have had to be added to it. As I have explained before, the use of alcohol, and subsequently the washing off of the alcohol, was in the line of improvement

END

and ~~was~~ only made the process absolutely certain, while formerly there were elements of uncertainty connected with ~~them~~^{it}.

X.Q.35- You bring your historical narrative to a conclusion with the statement that in your estimation the step from the proposition to make an etched record ~~with~~^{to} a successful & performance of the work marked a series of brilliant inventions. Was the use of alcohol in your estimation one of these brilliant inventions?

A- Yes. The use of alcohol I considered a brilliant invention. I also considered the use of the washing off of ~~the~~ the alcohol as a brilliant invention. This, however, does not mean that it would have been impossible to place the gramophone on the market without these inventions. For ~~one~~^{want} of these inventions the process would have been tainted by the elements of uncertainty to which I have referred, but it would have been quite practicable; commercially practicable. In fact, I considered the invention to have attained such perfection as to make it desirable to throw it upon the market. Mr. Berliner, however, had become supersensitive at that time. He aimed at the highest perfection and the highest security.

X.Q.36- It is quite possible then to make an etched sound record by flooding a zinc plate with a suitable etching ground tracing the record through the ground and treating the plate in an etching bath with the skill and precautions usually taken in the etching art to obtain a true line. Is that a fact?

A- No, this is not a fact. To my knowledge the

"flooding" of a zinc plate with a suitable etching ground for the purpose of making a good sound record, is not one of the precautions usually taken in the etching art. To "flood" ^a the zinc plate with an etching ground such as will offer no sensible resistance to the recording style and at the same time prevent the access of the etching fluid to the zinc plate, was an invention, a brilliant invention, made by Mr. Berliner, and ^{is} not found in the prior arts. The use of a proper etching fluid is also in my estimation an invention, a brilliant invention, made by Mr. Berliner, and not found in the prior etching art. If the skill and the precautions usually practiced in the etching art were employed, and nothing else, a sound record could not be successfully traced and etched.

Cross-
Xx2 ~~Examination~~ Examination Closed.

Re-direct by Mr. Horace Pettit.

R.D.Q.37- At the time this suit was brought who composed and who still compose the firm of Lyons and Bissing?

A- Myself, Joseph Lyons, and Mr. Gustav Bissing.

R.D.Q.38- What is your particular branch of the business of the firm?

A- I am in charge of the technological branch of the business, the law branch of it being in charge of Mr. Bissing. I am myself, neither by education nor by inclination a lawyer. I am not a member of the Bar, and do not pretend to know much of law. Whatever I know of law I have learned by intercourse with such gentlemen as Mr. Mauro, and I found

that the information which I ~~always~~ ^{thus} received was not always reliable. As I said before, I do not pretend to be a lawyer, and I am only an expert. Of course, I have learned something of the use of legal phrases while I was in the Patent Office, and afterwards as solicitor of patents, but the whole subject is foreign to ~~me~~ my training and to my inclination.

R.D.Q. 39- And you have been employed in this case by reason of your expert technical knowledge acquired as set forth in your direct examination?

A- This is the only reason why I was employed in this suit, and my partner, Mr. Bissing, had, of course, to go along with me.

R.D.Q. 40- Do you know who are ~~the~~ ^{the} legal counsel for the defendants in this case. If so, kindly state.

A- The legal counsel employed for the defense are Mr. Charles E. Mitchell, of New York, formerly Commissioner of Patents, and Mr. Horace Pettit, of Philadelphia, and my partner ^{there} Mr. Bissing. For all I know ~~they~~ may be more. I really take very little interest in the legal aspect of this case.

R.D.Q. 41- State whether or not you are pecuniarily interested in the results of this suit other than being a stockholder to the extent of 25 shares of stock in the United States Gramophone Company, if this incurs any interest?

A- I am interested in the outcome of this suit ~~to~~ to the extent which you have named. A rise of the value of stock of 100% would bring to me a gain of about \$13 a year in dividend.

R.D.Q.42- And this is the extent of your interest in the suit?

A- Yes.

R.2.42-R.D.Q.43- I would like to ask you in passing, whether you know S.T.Cameron, who has testified as an expert on behalf of Complainant in this case, and if so, I would ask you to state if you know what are his connections and relations with the law office of Mr.Philip Mauro, counsel for Complainant.

A- I know Mr. S.T.Cameron quite well. He has his office in the same building as Mr.Mauro, the offices communicating by a permanently open door, and he gives his name appears on the letter heads of Mr.Philip Mauro, and he is reputed as ^{associated.} ~~socially~~ in law practice with Mr.Mauro.

R.D.Q.44- Do you know whether his name appears upon the door of the offices of Mr.Mauro as a Member of the Bar?

A- Mr.Cameron's name certainly appears at some of these doors and I do believe that he is there ~~called~~ called a lawyer or an attorney at law.

- ReDirect Examination Closed. -

Joseph Lyons.

At a Stated Term of the Circuit Court of the United States for the Southern District of New York, held at the Court Room thereof in the Post Office Building in the City of New York, this 5th day of May, 1900!

PRESENT:

HON. E. HENRY LACOMBE,

Circuit Judge.

-----X
AMERICAN GRAPHOPHONE COMPANY :

-against-

NATIONAL GRAMOPHONE COMPANY :
and FRANK SEAMAN. -----X

IN EQUITY NO. 7063.

On patents No. 341,214;
341,288; and 375,579.

This cause having come on to be heard on motion for final decree in accordance with the annexed consent, it is on this 5th day of May, 1900, without costs to either party as against the other, ORDERED, ADJUDGED, and DECREED as follows:

That letters-patent of the United States No. 341,214, granted May 4, 1886, to Chichester A. Bell & Sumner Tainter; No. 341,288, granted the same date to Sumner Tainter; and No. 375,579, granted December 27, 1887, to Sumner Tainter, for improvements in recording and reproducing speech and other sounds and for apparatus therefor, are each of them good and valid letters-patent; that the complainant the AMERICAN GRAPHOPHONE COMPANY was, at the time of filing the bill of complaint herein, possessed of the full and entire

right, title, and interest in and to the same, and is entitled to sue for and to recover to its own use and in its own name all claims for the infringement or violation of said letters-patent or of any of them; and that the NATIONAL GRAMOPHONE COMPANY, one of the defendants herein, has infringed upon each of said letters-patent and has violated the exclusive rights of the Complainant under the same, by making or causing to be made, and using or causing to be used, and selling or causing to be sold, certain machines or apparatus for recording and for reproducing speech and other sounds, such talking-machines being commonly known as GRAMOPHONES.

And it being shown to the Court that the Complainant and the Defendant the NATIONAL GRAMOPHONE COMPANY have agreed on the amount to be recovered from the said NATIONAL GRAMOPHONE COMPANY by the Complainant in settlement of all claims for damages and profits on account of such infringement, and it further appearing that the said Defendant has duly paid such amount, it is further ordered that this settlement shall include all claims for damages or profits due to Complainant for infringement of its said letters-patent by all purchasers of machines from said NATIONAL GRAMOPHONE COMPANY, or from its successor the NATIONAL GRAMOPHONE CORPORATION; but that this settlement shall not include or affect the right of the Complainant to proceed against and recover from the BERLINER GRAMOPHONE COMPANY, or the UNITED STATES GRAMOPHONE COMPANY, or any person, firm, or corporation from whom the NATIONAL GRAMOPHONE COMPANY or the NATIONAL GRAMOPHONE CORPORATION has purchased infringing articles.

IT IS FURTHER ORDERED, ADJUDGED AND DECREED that a perpetual injunction issue against the defendant, the NATIONAL GRAMOPHONE COMPANY, in accordance with the prayer of the bill.

Esthacomb

U. S. Circuit Judge.

We hereby consent to the entry and filing of the above decree.

Philip Kano

Of Counsel for Complainant.

Stalder G. Morse

Solicitor and of Counsel for the Defendant, the NATIONAL GRAMOPHONE COMPANY.